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# AN INPUT-OUTPUT ANALYSIS OF THE EFFECTS OF RISING ENERGY COSTS ON CANADIAN INDUSTRIES

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# INTRODUCTION

In the nineteen sixties the Canadian economy enjoyed a period of rapid economic growth. It was also a period during which the consumption of energy increased very rapidly. Developments in the mid-1970s further characterize the sixties as a period when energy was cheap. Indeed, during the sixties and even into the early seventies, most of the prices of energy commodities fell in real terms. This period came to an abrupt end when the oil producing nations started to use the Organization of Petroleum Exporting Countries (OPEC) to substantially raise the price of oil. The power of OPEC was seen during and after the war in the Middle East in 1973. In January 1973, the price of landed crude (Arabian light) at Montreal was around $US 3.40 per barrel. A year later its price had jumped to $US 11.20 per barrel. In July 1978 the Canadian crude oil wellhead price stood at around $CDN 12.75. The rise in oil prices led the way. Rises in the prices of coal, natural gas and later in electricity, followed the lead set by the oil prices. Energy prices were no longer falling in real terms.

The rise in oil prices accompanied a rapid rise in the price levels of most of the industrialized world. By the mid-1970s most of the economies of the world were experiencing inflation. The part played by the increase in oil and other energy commodity prices was both direct and indirect. Higher energy prices led directly to increased costs of production and to increased prices. Increases in prices of goods and services, particularly of such commodities as transport services, household heating and food led organized labour to press for increased remuneration to cover the increased costs.

This stimulus given to increases in wage demands was not the only indirect stimulus to price increases brought about by the

rise in oil prices. Producers of other raw materials, in an effort to emulate the success of OPEC, strengthened their hold over the supply of their resources. While they had varying degrees of success in pushing up and holding the prices of their commodities, OPEC showed that it retained the power to press for further price increases. The rise in the prices of industrial commodities affected adversely the developing economies of OPEC member countries. Dependent upon industrial products for their development, the OPEC countries pressed for rises in oil prices to compensate for their deteriorating terms of trade. The price rises established by OPEC in the late seventies showed that they have been able to at least keep pace with the rise in the price level in the industrialized countries.

The importance of the direct and indirect effects of energy prices on the general price level is derived from the importance of energy in the modern industrial economy. The particular importance of oil derives from its extensive use, in all sectors of the economy. It is the extensive use of energy which makes it an important input, but at the same time it is this same characteristic which makes it difficult to generalize about the effects of rises in its prices. Energy is provided by different commodities and they are used in different intensities by different industrial processes. The industrial sector in 1975 consumed a third of the energy used in Canada. Defining the sectors in a different way, in the same year the non-residential sector consumed around 77 percent of the country's energy. Such sizeable sectors contain industries characterized by very different energy requirements. Of particular interest, and of importance, are those industries which require large inputs of energy with respect to their outputs.

A means of identifying such industries and of interpreting and measuring the effects of rising energy costs is provided by the technique of input-output (I-O) analysis. The very useful attribute of the I-O tables is that they provide one of the most extensive and detailed descriptions of the economy that are

available. The information contained in the tables provide measures of the impact of rises in the price of energy on the general price level and on the price level of particular industries. Statistics Canada I-O tables facilitate such exercises and this study has used them extensively.

The tables and the techniques of I-O analysis, however, have limitations. The limitations derive primarily from the assumptions that are implied concerning the behaviour of industries. These restrictions serve to qualify the interpretations given to the results purporting to measure the impacts of rises in energy prices.

In the I-O model firms are assumed to respond to rises in costs by raising their prices. Prices are perceived to rise by a process of 'cost push'. These increases occur instantaneously, with no time lags. The firms are assumed not to substitute lower price inputs for higher priced inputs. Such assumptions can be questioned. In consequence, the results obtained from the I-O models have to be carefully scrutinized before being accepted as measures of impact. Chapter 1 of the study attempts such a task. A description of the I-O model is given along with the assumptions that are implied about the behaviour of firms in the economy.

The I-O model can be used to 'explain' the behaviour of prices over time. This has not been attempted, for such an exercise was not seen as central to the study. Instead, the I-O model has been used for its descriptive powers. It has been used to identify those industries which are large users of energy and as a means of measuring the impact on the prices of commodities and industries of a set of price increases in energy commodities. These price increases were carefully selected. They approximate the increases in energy prices that were experienced in the mid-1970s and they also provide a range of increases sufficiently wide to allow interpretations to be made of possible alternative pricing policies. From the results of these price simulations, it

is possible to draw some tentative conclusions concerning the relative impact of price changes on industries and between a number of provinces in Canada.

Chapter 2 uses the I-O tables to provide a picture of the changing demand for and supply of energy commodities in Canada over the period 1961 to 1971. The relative energy intensities of particular industries are described, while Chapter 3 explores the effects that structural and technologocal changes have had over the period 1966 to 1971 on the use of energy commodities. Chapter 4 outlines in detail the price simulations and the ensuing impacts of these on the prices of commodities, industries and on items of final demand. The simulations measure such direct impacts; they do not attempt to explain the indirect effects of increases of energy costs on such a factor as wages. The chapter concludes by comparing a price simulation on the 1966 Quebec I-O tables with two similar simulations conducted on the 1966 Canadian I-O tables.

## SUMMARY

The task of examining the impact of rising energy costs on Canadian industries was approached by first of all establishing the past movements in the prices of energy commodities. Once these changes had been recorded, the next step was to specify the price simulations. These were chosen with respect to not only the past movements in energy prices, but also with a view to considering the effects of possible alternative energy pricing policies. Of particular interest, however, were the different impacts of the chosen energy price alternative on commodity and industry prices. An interpretation of these results required a thorough understanding of the assumptions of the I-O model and of the structure of the I-O tables.

The rapid rise in energy prices started with the rise in oil prices. The prices of oil from the producers belonging to OPEC started to rise in the early seventies and shot up in the year of 1973 to 1974. The highest price increases occurred in imported crude oil arriving at Montreal when it rose by some 208 percent between 1973 and 1974. The price of domestic crude oil has risen less dramatically. For instance, at Sarnia, Ontario, the highest price rise was recorded in the same year, 1974, when it rose by 40 percent. Natural gas prices rose by 50 percent in the Toronto market in the year 1974-75. Coal prices achieved their peak price rises a year earlier, when Canadian bituminous increased by over 91 percent. Electricity prices were slower to rise, many of the big increases occurring during the last two years. For instance in B.C. industrial users were faced with a 70 percent hike in electricity rates during the 1976-77 period, while in the current year, industrial rates in Nova Scotia have risen by 50 percent.

At the time of writing, the latest I-O tables were those

for the year 1971. These tables were used in the ten selected price simulations. The model used was the I-O price simulation model of the Structural Analysis Division of Statistics Canada. A distinction was made between primary energy and secondary energy commodities. The former were involved, in varying combinations, in the first eight simulations. The last two, Simulations 9 and 10, involved the secondary energy commodities of aviation gasoline, motor gasoline, fuel oil and other petroleum and coal products. Electricity, despite the fact that non-hydro generated electricity cannot be considered a prime energy commodity, was placed among the group of primary energy commodities.

The first simulation doubled the domestic and import prices of crude mineral oil. All other prices were held constant. The second simulation examined the situation where the import price of crude mineral oil doubled, but the domestic prices increased by only 50 percent. Simulation 4 doubled the domestic and import prices of natural gas, while Simulation 7 recognized the inter-related nature of the oil and natural gas commodities by considering the effects of doubling both the domestic and import prices of crude mineral oil and natural gas. A doubling of the import and domestic prices of coal were considered in Simulation 3, while Simulation 5 examined the impact of doubling domestic and import prices of electric power. In view of the expected growth of nuclear generated electricity plants in the future, the effects of doubling the price of uranium were examined in Simulation 6. Finally, Simulation 8 examined the impacts on the economy of doubling the domestic and import prices of crude mineral oil, natural gas, electricity and coal. The differing impacts on the prices of industry outputs reflect the total consumption of energy involved in producing the outputs of the industries. The total consumption of energy consists of direct and indirect consumption of energy. For instance, oil is used directly in the production of heating for apartments while other oil derivatives are used in the production of transport services which are needed to transport the oil to the apartments' basements.

Not all energy commodities, however, are used to provide heating, lighting and power. A considerable proportion of some energy commodities are used for feedstocks. Coal is used largely for feedstock in the iron and steel industry, and not for purposes of generating heat. In the I-O tables such distinctions are not made, so that the energy intensities of particular commodities and industrial outputs do not necessarily indicate that all of the commodity has been used for its energy.

The price simulation results indicate the impacts on the prices of individual commodities, industries, items of final expenditure and on the consumer price index. The tables contain a considerable amount of detail, such that the paper has reproduced only the more significant price impacts. The latter identified a group of commodities and industries as experiencing noticeable price increases in response to rises in prime energy commodities. Such commodities were the refined hydrocarbon commodites, the oil and gas pipeline commodities, a variety of chemical commodities, lime and cement. The industries experiencing noticeable price increases were the hydrocarbon refining industries, the manufacturers of industrial chemicals, the transportation industries, the cement manufacturers, iron and steel manufacturers, the pulp and paper industry, the aluminum smelting industry and the food processing industries.

The price impacts on these commodities and industries are illustrated by the results from Simulation 8, in which the domestic and import price of crude mineral oil, natural gas, coal and electricity prices were all doubled at once. Among the commodities, the secondary oil commodities of motor gasoline and aviation gasoline rose by 68 and 67 percent respectively. Petrochemical feedstocks registered an increase of 58 percent, while phosphates and cement prices rose by 15 and 14.5 percent respectively. In the case of the industries, the petroleum and gas well industry and the petroleum refineries increased in price by 93 and 70 percent

respectively. The lime manufacturing industry rose by 15 percent, as did the industrial chemical and the cement manufacturing industries, while the iron and steel and the pulp and paper mill industries rose by 12 and 9 percent respectively. The agricultural industry experienced a price rise of 6.2 percent, followed lower down by a group of food processing industries, such as the poultry processors (5.4 percent), dairy factories (5.2 percent) and the slaughtering and meat processors (5.0 percent).

The results of Simulation 8 indicate the weight of the hydrocarbon energy commodities so an examination of the simulations involving single energy commodities provides a number of distinctions. Oil price increases produced the largest increases in gasoline and fuel oil commodities and industrial chemical commodities. The largest increases in the prices of industrial outputs were in the industrial chemical industries and the non-metallic mineral producing industries. Natural gas price increases differed from oil price increases in that the commodity price effects were much lower. Of these commodities, the cement and concrete products and the industrial chemicals headed the rankings. In the case of coal price increases, the largest price effects were seen in the electric power and the iron and steel commodities.

Electricity price increases differed somewhat from the increases in the hydrocarbon energy group of commodities in that the industrial chemical group of commodities experienced the largest price increases. This group, as indicated, also experienced large jumps in price in the oil and natural gas price simulation. However, in the electricity price simulation this group of commodities dominated the rankings.

Simulations 9 and 10 considered the effects of doubling the secondary energy commodities. Of significance in these simulations were the increases in prices registered by the lime, cement and transportation (particularly air and truck) commodities. In the case of Simulation 9, hogs, poultry and live animals also showed substantial price increases. The industries experiencing

the substantial price rises included the industrial chemical manufacturers, aluminum smelters and refiners and the transportation industries.

Of the ten simulations, Simulation 8 led to the highest increase in the consumer price index (CPI). This was 4.8 percent. Doubling the domestic and import price of oil resulted in an increase of 2 percent, while a similar increase in electricity prices resulted in an increase of 2.5 percent. Of the sub groups of the CPI, the energy price increases had greatest impact on transportation, housing and food costs. The transport sub group had the largest increase in five of the simulations, housing was first in four of the simulations, while food in three of the simulations came second. One of the interesting points raised by these results is the importance of indirect energy inputs used in the production of such commodities as clothing and food. Although these commodities register only moderate direct inputs of energy in their production, energy commodities such as oil and gasoline are required in substantial quantities in the production of the artificial fibres used in the clothing industry and of the paper and transport services used in the food industry.

The impacts of the simulations on export prices showed electricity price increases to be of considerable importance. Oil, gas and coal commodities were exported in considerable quantities, with the result that raising the domestic and therefore the export prices raised directly the export price index. In contrast, electricity prices operated by raising the prices of those commodities which were exported in considerable quantities. Such commodities were motor vehicles, motor vehicle parts, newsprint and other paper stock, lumber and timber. A comparison of Simulation 1, in which crude mineral oil import and domestic prices were doubled, with Simulation 2, in which domestic oil prices were raised by 50 percent while import prices were doubled, showed that keeping down domestic oil prices helped to keep down the prices of exports. This was particularly noticeable in the lumber, paper products industries and motor vehicle engines and parts industries.

The latter results could have some significance in the formulation of Canada's oil pricing policies. In view of the importance of the U.S. in Canada's trading activities, the price of energy commodities, and oil prices in particular, vis a vis the prices of these commodities in the U.S., are of some considerable importance. Melvin [43] conducted a study on the Canadian I-O tables for 1966, in which he examined the effects of doubling the prices of hydrocarbon fuel on the prices of industrial outputs. These prices were compared with a similar exercise conducted on the U.S. economy. He found that there were only twelve industries in which the total effect in Canada were less than they were in the U.S. and so concluded that Canada would be at a price disadvantage with the States if it moved its oil prices above those prevailing in the U.S.

The Canadian and U.S. I-O tables differ considerably, such that a comparison of the results is made difficult. Instead of pursuing this comparison, the study examined the effects of doubling the price of oil in Quebec and comparing the results with doubling the price of oil in Canada. The national and the Quebec tables are closely approximated in their structure, so that such a comparison provides a promising set of results. The year examined was 1966. The differences between the two sets of price impacts showed that Quebec's main exports to the rest of Canada, namely clothing, electric products and metal products, experienced lower increases in price than similar commodities in Canada. It would appear that one of the reasons for the lower costs in Quebec was because a large proportion of electric power generation came from hydro plants, rather than from oil burning thermal plants.

The study also attempted to measure the response of consumers to the changes in the prices of final consumer goods and services. Faced with different price rises among the consumption goods, consumers are likely to respond by purchasing less of the more expensive and more of the less expensive goods. The extent of

this substitution will depend on the price rises and the price elasticities of demand. These in turn will determine the extent to which the less energy intensive goods are substituted for the more energy intensive goods.

Estimates of the short and long run price elasticities of expenditure for the items in the final expenditure sector were calculated and applied to the price changes resulting from Simulation 8. The latter was chosen because it resulted in the largest price increases of the ten simulations. A comparison of the short and the long run price elasticities showed that a doubling of the prices of the prime energy commodities was likely to reduce final consumer expenditure in the short run by 2 percent and in the long run by 6.5 percent. An examination of the mix of items of consumer expenditure showed that in the case of the short run demand price elasticities, the share of final expenditure accounted for by those commodities with a high price response fell only slightly, from 6.6 to 5.9 percent. In the high price elasticity demand case, the same group of commodities had their share halved from 8.2 to 4.1 percent.

The items with the high price increases were those with the high energy intensities. The estimates show that a doubling of the prices of the prime energy commodities will cause some shifting among the final expenditure items, but it is not likely to be substantial. This result, in fact, emphasizes the overall impression of the price impacts. It is that despite the doubling of the prices of energy commodities, the impacts on commodity and industry prices are surprisingly slight. A doubling of the domestic and import prices of oil raises the CPI by less than 2 percent, while a similar increase in the price of electricity resulted in an increase of 2.5 percent. These results, however, refer only to the effects on prices of increasing energy costs. They do not record the effects they have on stimulating the costs of other factors of production. Some studies, however, have suggested that these effects have been substantial.

CHAPTER 1

# THE APPROPRIATENESS OF INPUT-OUTPUT ANALYSIS AS A MEANS OF ANALYZING THE EFFECTS OF RISING ENERGY COSTS ON CANADIAN INDUSTRY

## 1.1 Introduction

The industrial sector of the economy consumes a large proportion of the total demand for energy in the economy.[1] In certain industries, energy inputs constitute a high proportion of total costs of production. Large increases in energy costs will cause certain industries to experience substantial increases in costs. The response of the industrial sector will have considerable effects on the demand for energy. Changes in the costs of industrial products will cause varying shifts in demand, which in turn will cause changes in income and employment.

This aggregate demand for energy by the industrial sector will depend primarily on the level and composition of the final goods and services for which energy is used to produce and on the cost of energy relative to the cost of other inputs in the productive process. The cost of energy relative to the cost of labour and capital will over time affect the composition of output and in turn the demand for energy.

The demand for energy will be affected by the degree to which various industries adopt energy saving investments. It will also be affected by changes in technology of such investments and the changes in the demand for output away from the more to the less energy intensive commodities. An appreciation of these impacts involves a detailed, comprehensive picture of the economic system.

It is a picture which also needs to be supplemented with an understanding of how the constituent industries respond to a rise in energy costs, the manner in which they transform these cost changes into price changes and the response of the consuming sector to these price changes.

The strength of the I-O tables is that they can provide a detailed, comprehensive picture of the economy which few, if any, other approaches can produce. The limitations of the tables stem primarily from the assumptions they make concerning the behaviour of industries. These restrictions serve to qualify the interpretation given to the results purporting to measure the impacts of large jumps in energy costs. They also serve to limit the application of the tables, with the result that they narrow down the type of analysis that can be undertaken. It is the purpose of this chapter to set down the assumptions underlying the I-O tables, and to show how these translate into assumptions concerning industrial behaviour. With this understanding of the I-O tables, it will then be possible to state the tasks that the I-O tables are best able to handle and from which useful deductions can be drawn.

Section 1.3 introduces the concepts of the I-O, while Section 1.4 describes the I-O models used by Statistics Canada. These describe the Canadian economy and they are used in the price simulations which are outlined in Chapter 4. Section 1.5 describes more formally, in algebraic terms, the models used in the study, while Section 1.2 briefly describes the extent of the past increases in energy and other factor input prices.

## 1.2 Energy Price Increases: 1961-78

The rise in energy prices was seen most dramatically in the rise of imported oil prices, an event which accelerated the price rises in other primary energy commodities. In January 1973 the price of landed crude (Arabian light) at Montreal was around $US

3.40 per barrel. A year later it had jumped to $US 11.20 per barrel and by mid July 1977 it had reached $US 14.05 per barrel.[2]

Canadian wellhead prices were slow to rise, at first. In January 1974 they averaged around $CDN 3.88 per barrel, but then increased to $CDN 6.50 in April 1974 with the introduction of the new pricing policies. In response to the authorized price hikes, they had risen to $CDN 12.75 by July 1978. The jump in domestic oil prices in 1974 opened a gap between oil and natural gas prices. This was partially bridged in the following year with the establishment of the Toronto city gate price as the 'reference' price, set at levels around 85 percent of the price of the Btu equivalent value of crude oil.

The world market in oil started to change in the late 1950s. Foreign imported oil could be sold at prices lower than domestically produced oil. The response of the U.S. government was the imposition of import controls in February 1959.[3] In Canada, field prices started to drop in response to lower international prices. Then, in 1961, the Royal Commission on Energy recommended the protection of domestic oil prices from international imports. The ensuing 1961 National Oil Policy divided Canada into two regions: the area west of the line known as the Ottawa Valley Line, which was the preserve of domestic oil production, while the area to the east was to be provided for by the imported oil.

Prices west of the Ottawa line were 'protected' from the downward pressure exercised by cheaper imported oil. The result was the emergence of a market west of the Ottawa line in which prices exceeded those charged to the consumers in the east. This differential existed until the Fall of 1973, when the effects of the power of OPEC to push up the price of their members' oil were dramatically expressed. The result was a reversal in the differential; prices in the east exceeded those in the west. Prior to October 1973, however, significant policy changes were introduced. The Canadian crude wellhead price of $3.80 per barrel was temporarily frozen at its August 1973 level, while a charge was levied

on exports of Canadian oil to the U.S. (October, 1973). The following year saw the establishment of policies which are presently in operation. These have been summarized in a recently published Department of Energy, Mines and Resources document [18] as:

> The commitment to a single price policy for crude in Canada, subject to transportation differences.
>
> The commitment to remove the undervaluation of natural gas in both domestic and export markets;
>
> The intention to use our resources to phase in price increases for oil and gas in a manner that affords an opportunity for Canadian consumers to adjust to higher prices.[4]

The 'single price oil policy' in Canada was accepted by the provincial governments in March 1974, along with a programme of phased increases in Canadian wellhead prices. A further agreement of this meeting was that the revenues from the export charge would be used to finance payments to oil importers so that they could sell imported oil to eastern Canadian consumers at prices consistent with Albertan wellhead prices. An Oil Import Compensation Fund was established in April 1974,[5] administered by the Energy Supplies Allocation Board. The compensation is currently based on the average delivered price of all crudes imported into Canada.[6] The export revenues, however, were soon shown to be inadequate to compensate for the rapidly rising prices of imported oil. In consequence, an excise tax was imposed on the sales of motor gasoline for non-commercial use.[7]

The single price policy had therefore been wed to Canada's export policy, whose objective (after October 1974) was to limit exports to the United States in order to conserve Canadian reserves. In October 1974, the National Energy Board (NEB) reported that Canadian oil supplies beyond 1982 would be inadequate to serve the traditional markets west of the Ottawa line as well as part of the Montreal market. In consequence, the NEB recommended that exports should be phased out. Gas exports have also been subjected

to licence control and price regulation, the latter being pitched at levels competitive with the prices of substitute energy forms.

The Petroleum Administration Act, passed in 1975, empowered the NEB with authority:

> To achieve a uniform price, exclusive of transport and service costs, for gas consumed in Canada and outside the province of production and to maintain a reasonable balance between the prices of alternative fuels in Canada.[8]

An agreement with the producing provinces was established in October 1975. The Toronto city gate price, the 'reference price', approached 85 percent of the Btu oil equivalent price. All the other prices for natural gas sold in interprovincial trade are derived from this reference price, which is based on the transportation tolls authorized by the NEB. The argument supporting parity between oil and gas prices has been expressed by the Department of Energy, Mines and Resources.[9] It is based on the understanding that with the prospects of increased oil prices, natural gas, as a close substitute for oil, would have been substantially undervalued, resulting in a reduction in the incentive to develop natural gas supplies.

In view of the policy of parity between oil and gas prices, both gas and oil producers listened with interest to the Prime Minister's opening statement to the First Ministers' Conference in April 1975 which outlined the policy that:

> ...the price of oil in Canada must go up -- up towards the world price. It need not go all the way up. We should watch what happens to the world price and decide from year to year what we should do.

This policy of linking domestic oil and gas prices with the world price for oil has remained implicit. Rather than stating that the domestic prices will be <u>equated with</u> the world price, the government has chosen to select a set of target figures in the region of 'expected' world prices. The Minister's[10] statements suggest domestic price increases of $1.00 every six months will

occur until the domestic price reaches $CDN 13.75.[11] This is scheduled to be reached in January 1979. In July 1977, Arabian 'marker crude' was priced at $US 12.70, while the landed price (of crude oil from all countries) at Montreal was around $US 14.05.[12]

The hesitancy in equating domestic with import prices is understandable, in view of the uncertainty surrounding the pricing policies adopted by the U.S. government and the subsequent price differentials that could ensue between competing industries in Canada and the U.S. Indeed, one of the implicit restrictions applied to the scheduled increases is that the Canadian prices must not be set significantly higher than the average prices in the U.S.[13] Another restriction is that if world prices should suddenly drop, Canadian prices must not exceed the prevailing international prices.[14]

This brief survey of Canadian energy policy suggests that the future level of domestic oil and gas prices will be strongly influenced by the behaviour of international oil prices and the pricing policies accepted and authorized by the U.S. government. Electricity prices have not been as directly affected by international developments. There is some interprovincial and international trade in electricity, but electricity is largely generated and consumed within the provinces. As a result, the rate making or authorizing bodies reside within provincial jurisdictions. Differences in provincial control and the different methods of electrical generation have resulted in substantial differences in rate structures and rate levels between the provinces.[15]

In 1976 hydro electric plants accounted for 62 percent of Canada's net generating capabilities. Thirty percent was provided by conventional steam plants, while nuclear steam plants, internal combustion plants and gas turbine plants generated 3.7, 0.7 and 0.6 percents respectively.[16] By 1981 hydro's share is expected to drop to 57 percent, while the largest gains are expected to accrue to nuclear steam plants.[17] In general, conventional steam plants use coal, heavy fuel oil and natural gas, while internal combustion

plants use diesel oil. Gas turbine plants use a variety of energy commodities in the form of light fuel oil, diesel oil and natural gas. In 1975 heavy fuel oil was used to produce 2.6 percent of total electricity generation, natural gas 5.1 percent, while uranium and water accounted for 5 and 72 percent respectively. All forms of coal, from domestic and imported sources, accounted for over 14 percent of total electricity generation.[18]

The use of coal fired electrical generating plants is heaviest in Ontario, Alberta, Saskatchewan and Nova Scotia. In 1976 Ontario had 58.8 percent of Canada's thermal capacity and Alberta 11.1 percent.[19] Ontario's commitment to steam generated plants is increasing, for its plans suggest that by the last decade of the century, 80 percent of Ontario Hydro's electricity output will depend on coal and uranium.[20]

As this description of the electricity suggests, the major use of coal is in the generation of electricity, followed by the metallurgical uses. These two markets will determine the future course of the coal industry, although other industrial uses and coal gasification and liquefaction may take on increased significance in the longer run. It is a course which in recent years has been changing. Since 1969 the industry has undergone the most rapid expansion in its modern history. Between 1969 and 1973 coal production doubled, while prices more than doubled.[21] In 1971 domestic output exceeded imports, a situation which had not occurred since the war. The major source of this growth came from an expansion in demand from abroad, especially from Japan.[22] Yet it is a development which has further emphasized the distances between Canada's coal using areas and its sources of supply. The major coal resources are at either end of the country, at the Maritimes in the east (Nova Scotia and New Brunswick) and Saskatchewan, Alberta and British Columbia in the west. The major consuming province is Ontario, which lies on average only 450 miles from the U.S. coal mining areas, but some 2,200 miles from Canada's major supplies in the west. As a result, the west exports to Japan,

while Ontario imports from the States, making Canada simultaneously the sixth largest exporter of coal in the world and the third largest importer.

Moving from an analysis of the changing policies with respect to energy commodities to an enumeration of movements in the prices of these commodities in particular markets presents difficulties. The information available provides useful measures of the prices paid to the extractors and producers of energy and as such they are able to indicate general movements and trends. As representative measures of the costs of energy facing industrial consumers, the available data have considerable limitations. The rates charged by many utilities, particularly in the natural gas and electricity sector, vary according to the quantity consumed. Many utilities also negotiate special contracts with industrial users which are not publicly disclosed.[23]

Table 1.1 summarizes[24] the past current price increases in energy commodities. The energy commodities are electricity, coal (bituminous), crude oil and natural gas and the periods selected run from 1960 to 1977. In the case of crude oil, the highest price increases occurred in imported crude arriving at Montreal when they rose 208 percent between 1973 and 1974. Prices of domestic crude at Sarnia, Ontario, have been less dramatic, over 40 percent in the same year being the largest jump. Natural gas prices registered their highest rises in 1974-75 and 1975-76, when the price in the former year at the Toronto city gate rose by over 50 percent while in the latter year the price paid by industrial users in Ontario rose by almost 50 percent.

Coal prices have also gone through similarly large jumps in price during the mid-seventies. The highest increase appears to have been in 1973-74, when Canadian bituminous increased in price by 91 percent. In contrast, electricity prices over the same mid-1970s did not rise as fast as the previously mentioned energy prices. However, the figures displayed in Table 1.1 are averages for all consuming groups. A separation of the industrial users

TABLE 1.1

PAST PRICE INCREASES IN ENERGY COMMODITIES
(current prices)

| Energy Commodity | Source | Units | Period and Average Percentage Change | Domestic Prices | Imported Prices |
|---|---|---|---|---|---|
| Electricity | [1] | Av. Annual Change in Revenue per kW.h | 1970-76 | 7.5 | |
| | | | 1974-75 | 17.0 | |
| | | | 1975-76 | 15.0 | |
| Coal (Bituminous) | [2] | Av. Annual Price Change in Cents per Btu | 1970-75 | 6.1 | 10.0 |
| | | | 1971-75 | 22.6 | 27.0 |
| | | | 1973-74 | 91.7 | 14.5 |
| | | | 1974-75 | 25.7 | 65.7 |
| Crude Oil | [3] | Av. Annual Change $CDN per barrel | 1962-77 | 17.5 | 28.8 |
| | | | 1971-77 | 36.9 | 72.4 |
| | | | 1973-74 | 41.6 a | 208.0 b |
| | | | 1974-75 | 36.0 | 24.0 |
| | | | 1976-77 | 18.8 | 14.3 |
| Natural Gas | [4] | Av. Annual Change in $CDN/MMBtu | 1971-74 | 8.7 | |
| | | | 1974-75 | 51.7 c | |
| | | | 1975-76 | 47.7 | |
| | | | 1976-77 | 20.0 | |

SOURCES: [1] Protti [17], Exhibit 2.24.
[2] Ellison [15], Table 3.15, page 71.
[3] Ellison [15], Table 3.1, page 41.
[4] Ellison [15], Table 3.9, page 58.

NOTES: (a) Prices at Sarnia, Ontario.
(b) Prices at Montreal, Quebec.
(c) Prices at the Toronto City Gate.

suggests that these rose at a rate faster than the average. In Ontario in 1975-76 average industrial rates rose by 21 percent. A similar rate of increase was registered in the following year (1976-77).[25] In Nova Scotia, where many of the plants are fueled by increasingly expensive oil, industrial rates have been increased by 50 percent for the current year.[26] Even higher rates have been registered in British Columbia, where in 1975-76 industrial users experienced a 50 percent hike in rates while in the following year they rose by 70 percent.[27] These rate increases in the electricity sector indicate the regional differences in rate increase. However, two general points appear to be clear. The first is that industrial rates have risen faster than the rates charged to other users. Secondly, users are presently experiencing the somewhat delayed price hikes that occurred earlier in the other energy markets.

The movements in the prices of energy commodities are illustrated in Table 1.2 and Figure 1.1, which show the movements of prices over the period 1962 to 1975. They have been deflated by the consumer price index and expressed in index form, a transformation which suggests that during the sixties energy prices in real terms fell. The trend was reversed when the prices of imported crude rose in 1971 and then leapt in 1974. Natural gas price increases are shown to have been a little behind the increases in oil prices, while electricity prices in 1975 had yet to experience the rises that they were later to incur.

This examination of energy prices has shown that they rose sharply in the early and mid 1970s. Firms, however, use labour, capital and other raw materials as well as energy in producing their goods and services. The prices of these inputs, as well as those of the energy commodities, influence firms' decisions to substitute one input for another.

An indication of the movements of these prices is shown in Figure 1.2, which displays the movement in labour, capital and energy costs facing manufacturing industries in Ontario[28] over

TABLE 1.2

INDICES OF ENERGY PRICES DEFLATED BY THE CPI: 1962-75
(1962 = 100)

| Year | Consumer Price Index 1962 = 100 (1) | Average Price Canadian Crude (Wellhead Price) (2) | Landed Price Imported Crude Oil Montreal (3) | Average Wellhead/Plant Gate Price of Natural Gas (4) | Average Revenue /kWh for all Customers, Canada (5) | Price Imported Bituminous Coal Used in Electricity Generation (6) |
|---|---|---|---|---|---|---|
| 1962 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1963 | 101.7 | 105.8 | 96.8 | 107.4 | 106.0 | 98.8 |
| 1964 | 103.5 | 105.3 | 92.9 | 110.7 | 102.0 | 94.5 |
| 1965 | 106.0 | 103.1 | 87.3 | 106.6 | 100.0 | 92.2 |
| 1966 | 110.0 | 99.5 | 82.0 | 107.4 | 93.0 | 87.6 |
| 1967 | 113.9 | 118.3 | 78.5 | 106.6 | 93.0 | 85.6 |
| 1968 | 118.6 | 92.4 | 76.7 | 102.4 | 91.0 | 80.1 |
| 1969 | 123.9 | 88.3 | 71.4 | 97.5 | 88.0 | 78.1 |
| 1970 | 128.1 | 87.0 | 67.2 | 97.5 | 88.0 | 80.7 |
| 1971 | 131.8 | 92.4 | 75.3 | 93.3 | 90.0 | 92.5 |
| 1972 | 138.1 | 89.2 | 79.2 | 94.2 | 84.0 | 93.1 |
| 1973 | 148.5 | 102.2 | 78.1 | 96.6 | 82.0 | 89.9 |
| 1974 | 164.7 | 154.4 | 217.6 | 137.1 | 79.0 | 93.1 |
| 1975 | 182.5 | 175.4 | 243.6 | 252.0 | 83.0 | 139.0 |

SOURCES: Taken from Ellison [15], Table E.5.
The numbered columns refer to tables in the above study and to official publications. They are as follows:

1. Canadian Petroleum Association Statistical Year Book 1975, pages 71 and 76.
2. Ellison [15], Table 3.1.
3. Ellison [15], Table 3.1.
4. Canadian Petroleum Association Statistical Year Book 1975, pages 71 and 76.
5. Ellison [15], Table 3.16.
6. Ellison [15], Table 3.15.

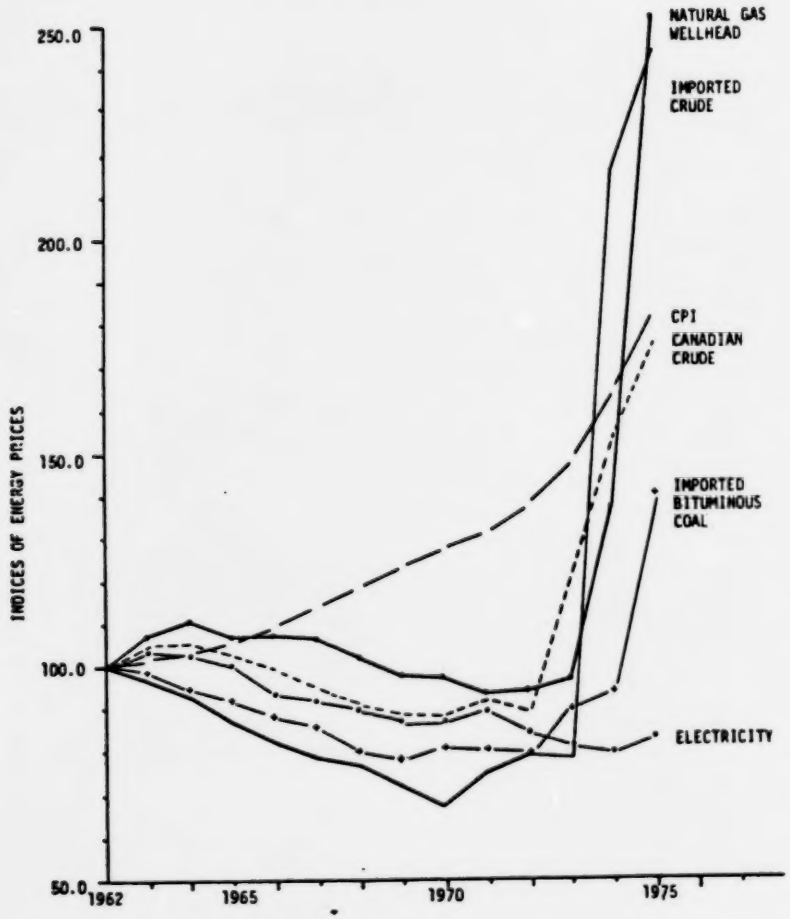



FIGURE 1.1: Indices of Energy Prices Deflated by the CPI 1962-1975
See Table 1.1 (1962=100)

the period 1962-74. The prices have been deflated by the CPI with 1962 = 100. Details of the sources used in the figure are displayed in Tables D.3 and D.4. The energy price index represents the dollar cost per Btu while the labour index measures the labour cost (wages and salaries) of all employees in the sector. The capital index measures the deflated dollar values of the capital stock used in the manufacturing sector.[29]

As Figure 1.2 indicates, the energy price index showed a dip down in 1972 and 1973 after a rise in 1971. It will be recalled from Figure 1.1 that during these years natural gas prices and electricity prices had not yet accompanied oil prices in its rise which began in 1971. Natural gas wellhead/plant prices started to jump upwards in 1974, but, owing to the lag effect, these were not fully registered in the prices charged to industrial users. In the case of electricity, average prices in real terms were still falling owing to the delay in adjustment by the electricity utilities to the increased costs of coal and oil.

Also of significance is the movement of the energy price index relative to the capital and labour cost indices. Over the period labour costs rose faster than the prices of energy and capital. Labour costs rose steadily in real terms in the 1960s, a period when real energy prices were falling. The jump in oil prices in 1974 was far from sufficient to cause energy prices to catch up with movements in labour costs. Capital costs rose rapidly until the mid 1960s after which they dropped back to their level at the beginning of the period, and remained about at the same level until 1973.

These two pieces of graphical analysis for the period 1962-75 show that crude oil prices rose rapidly and earlier than natural gas and electricity prices. Such was the difference in these increases that firms with a choice among their energy commodity inputs were likely to be attracted to substitute the lower priced for the more expensive commodities. The price of all energy

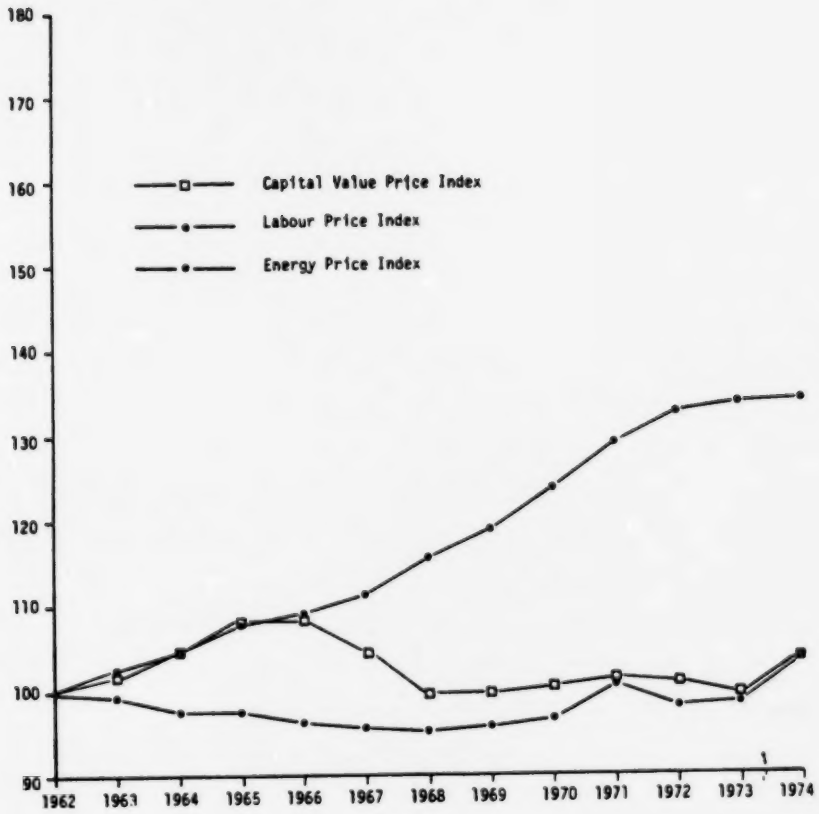



FIGURE 1.2: Graphical Representation of Price Indices of Factor Inputs Used by Ontario Manufacturing Industries: Energy, Capital and Labour Indices 1962 to 1974. 1962 = 100.0 (Constant 1962 Dollars)

SOURCES: Refer to sources listed with Table D.3 in Appendix D.

commodities used in the manufacturing sector rose much less than the prices of labour inputs,[30] a revelation which suggests, while there may have been a 'crisis' caused by oil price increases in the mid-seventies, there was not a 'crisis' in energy prices.

## 1.3 Input-Output Tables and Analysis: The Underlying Assumptions

An I-O table (or matrix) is a set of linear formulations connecting the levels of activities in the various segments of the economy. I-O analysis is the economic interpretation of these formulations.

These two descriptions serve to introduce the general objectives of the I-O tables and the I-O analysis. In viewing the economy as a 'general system'[31] the prime objective of the tables is to formulate and to statistically estimate the structure of the economy. The 'general system' arises from the perceived interdependence of the production and activities of the industries. This interdependence is derived from the fact that the outputs of industries serve as the inputs to other industries while the outputs of the latter also can serve as the inputs to the former industries. For instance, coal is produced from mines and is used in iron making which is used in the machines and shovels which are used to mine the coal.

The I-O model divides the economy up into sectors (or industries) and from these entities come their outputs. The output of any sector is determined by discovering the amount of its product which each other sector consumes. By adding each of these sector consumptions, the output of the given sector is determined. Crucial to the model are the assumed production functions involved in producing the outputs. A fixed-proportions production function is assumed, such that the quantity of each input consumed by a sector is in direct proportion to the quantity of output produced by that sector.

The I-O model in its simplest form divides the economy into n sectors. The levels of output of each of these n sectors depends on the levels of outputs of the other sectors. The relationship between the inputs and outputs of each sector are perceived as being linear. Mathematically the economy is formulated as consisting of a set of n linear equations in n variables. The solutions to these equations can then be simply solved.

In this simple form consumers are classified as belonging to a 'household' industry, which produces labour services and whose consumption is directly proportional to the output of these services. The government and foreign trade sector are similarly regarded. The model is 'closed', in that it accounts for or 'explains' all the consumption.

An adaptation to such closed models has come with the introduction of a final demand sector for the products of the economy's sectors. This sector consumes but does not produce. The changes in consumption are exogenous and are not explained in this 'open' model.[32] The final demand sector is often subdividided into a number of sectors; private consumption, government demand and net exports being some of the often used subsectors. The addition of this final demand sector adds to the descriptive power of the basic I-O model. For instance, the tables of the open model indicate how the output of an industry is used up as inputs in the production of intermediate products and how much is left over for final consumption among the final demand sectors.

An example of the use of the model and of the role that its assumptions play in the interpretation of the results is illustrated by way of an answer in response to a question. For example: How much coal production is needed to satisfy an increase in expenditure of one dollar's worth of final demand expenditure?

The sum of coal needed to be produced to satisfy the consumer demand can be envisaged in the form of an infinite series. The economy will have to produce as much coal as consumers will use directly plus the coal needed to produce the inputs for these final

consumers. Added to these direct demands will be the coal needed to produce the inputs which are in turn used to manufacture those inputs which go into these final products. The series continues on ad infinitum by adding the coal that is needed for the inputs to make inputs to make the inputs for the final product. As this example indicates, an integral part of the I-O tables of this model is the construction of a table which indicates the direct and indirect effects of changes in final demand. It shows the total expansion of output in all sectors as a result of the expenditure of one dollar's worth of final demand expenditure. A number of methods can conceivably be employed to calculate the combined direct and indirect effects. One method is outlined above: an iterative step-by-step method. Another is to take the set of linear equations which describe the relationships of inputs to outputs and to transform them into matrix form. Using matrix algebra, this involves taking the difference between an identity matrix and the input coefficient matrix. From this difference a transposed inverse matrix is calculated. The solution to these sets of equations forms a matrix of total (direct and indirect) coefficients representing the total requirements per dollar of final demand expenditure.

At this point it is useful to draw together the integral parts of this open, square I-O model. The tables provide a detailed picture of the flow of goods and services that individual industries buy from and sell to each other in one particular year. These flows are measured at producers' prices,[33] and in dollars.[34] By dividing each of a sector's inputs by its total output a matrix of I-O coefficients (direct technical coefficients) is formed. These technical coefficients[35] show the amounts that a sector purchased from all other sectors and from the value added per unit of its own output. They also form a set of linear equations connecting the outputs of all industries, the general solution to which expresses the unknown industry outputs as linear combinations of final demand.

As the coal example showed, this model can be used to analyze the generation of outputs throughout the economy as a result of change in the final demand sector. It can also be adapted into an energy I-O model, in which the economic activity is expressed in units of energy (British Thermal Units).[36] Similar impacts can be handled with this form of the model as with the conventional model except that the results are measured not in dollars, but in Btus per dollar. Most importantly for this study, the I-O model can be transformed and used to analyze the impacts of factor prices throughout the economic system. In such a price I-O model the familiar input coefficients represent the costs per unit of output and, because they are invariant with respect to price, the underlying assumption is that a change in prices will not give rise to substitution among the inputs. This is one of a number of assumptions of the I-O model which now needs to be examined if an appreciation is to be made of the results of the model.

The basic open square I-O model rests upon a set of assumptions, the two most important of which are: that each productive sector produces a single commodity[37] and that in all productive processes, all inputs are employed in rigidly fixed proportions.

The first assumption, based as it is on empirical expediency, raises questions concerning the possible heterogeneity of firms and commodities which are aggregated together into an industry and described as an industry's output. In an industry with many different sized firms and producing products which are not identical, the assumption is that output determines inputs uniquely only if it can be assumed that the product mix of the industry remains constant. The larger the number of sectors and industries, the less the diversity contained within the industry and consequently the less chance of error from this source.

The assumption that all inputs are employed in rigidly fixed proportions raises the question of whether it is realistic to ignore the possibility that firms are able, and indeed respond, to

changes, such as price increases, by substituting one factor for another. Large jumps in relative input prices, such as occurred in the energy commodity prices in the early to mid-1970s suggests that firms are likely to engage in substituting the cheaper for the more expensive inputs. Furthermore, while this production function may be an adequate description of many parts of the industrial sector, it is one which cannot be so readily accepted as an assumption of the behaviour in the agricultural[38] or government sectors.

The process of adjustment in the model is assumed to be instantaneous, for the rounds of impact calculated from the tables imply no sequence of time. There is no price adjustment up or down until the market is cleared. Nor do any factor substitutions take place in the long run. The coefficients in the model are calculated from an economy assumed to be in equilibrium, in which demands match supplies.

The assumptions used by the I-O price model need to be carefully examined when interpreting the magnitude of the impacts of price increases on the economy. The assumption of the model that there is no substitution between factors will tend to overstate the effect of price increases in the sense that firms are likely to substitute the cheaper for the more expensive inputs. Secondly, the assumption of instantaneous price adjustments masks the fact that the impact of price changes will take some while to work through the economy.

The assumptions quickly expose a number of questionable approximations concerning the economy and how it works. These in turn lead to qualifications concerning the use of the I-O model in analyzing the questions posed by this study. These will be summarized in the conclusion to this chapter. Meanwhile, it should be recognized that what we have described, in the barest outline, is a form of the I-O model we have named as 'square, open and static'. Although it has characteristics in common with many I-O models, there are different forms of this model which lead to different interpretations. One such model is the Statistics Canada I-O

model. The I-O price model of Statistics Canada is one of a set of models and is the one used in the price simulations undertaken in this study. These models shall be described in the following section and treated more formally in the succeeding section.

## 1.4 The Canadian Input-Output Model

The square I-O model described in the last section suggested that one of the problems of using the model is that the technical coefficients are derived from data originating from multiproduct establishments engaged in complex commercial activities. Part of the imprecision results from aggregating together under the entity of an 'industry' production structures and the marketing arrangements. These are activities which are determined by different sets of factors. The separation of these activities allows greater precision to be achieved when calculating the parameters of the model. It is by such a separation that the Canadian I-O models have been able to add to the precision of the analysis.

The 'basic'[39] Statistics Canada model is described as the "Open Output Determination I-O Model." This model is built around two specifications. The first specifies the function which allocates the production of commodities among industries. The second specifies the production functions of industries and these determine the requirements of industries for commodity inputs.

The first specification is the very simple one that industries maintain their share of the market for each domestically produced commodity whatever the level of commodity production. The first matrix of the model is one containing coefficients showing the share of the output of each commodity by each industry. The second specification concerning the production functions of industries is the familiar fixed proportions assumption. The assumption states that the values of inputs of each industry are fixed proportions of the value of the total output of the industry. These two specificiations form the first two sets of tables, the Make

(Output) Matrix and the Use (Input) Matrix.[40] Together with the Final Demand Matrix, these rectangular tables, in which the commodities outnumber the industries, constitute a large part of the empirical content of the model.

The workings of the model can be illustrated by following through the impacts of changes in the final demand for a particular commodity, say natural gas. As this commodity is supplied by domestic production, additional deliveries of commodities are needed as intermediate inputs to the industries supplying natural gas to final demand. The values of these intermediate inputs are determined by the way the market share matrix allocates production of commodities to particular industries. In turn the input requirements of each industry are determined by the coefficients in the industry technology matrix. After the total requirements for all industry outputs engaged in satisfying the final demand requirements have been obtained, the required prime inputs are obtained by assuming that they are required in proportion to industry outputs.

The assumptions underpinning this rectangular I-O model are the same as the ones outlining those described in the square I-O matrix. Adjustments to changes are instantaneous and industries are assumed to make no substitution between commodity inputs.

The Canadian I-O models form part of the country's system of national accounts, for it can be seen that in addition to charting the flows of commodities through the economic system, the I-O tables measure the value of economic production, gross domestic product (GDP) and expenditures on GDP. This is a useful connection, for by undertaking careful adjustments, considerable additional information can be used from the data which constitutes the national accounts.[41] In this way the interpretation of the tables can be considerably enhanced. Provincial and international comparisons, which are often helpful in placing the results of analysis in a wider context, are less accessible. Of

the provinces, Ontario built an I-O model using data from 1966,[42] but like the U.S. model, it is a square matrix model. Furthermore, the Ontario model is somewhat dated[43] and is aggregated in such a way that specifying a useful breakdown of energy industries is difficult.[44] The latest available U.S. model is dated one year later (1967), and despite its degree of disaggregation (367 industries),[45] there is the problem of comparing a square with a rectangular I-O model. Assuming the industries and commodities in the two models could be suitably matched, there is the problem of obtaining comparable coefficients. The rectangular I-O model could be 'squared' but then the refinement of the rectangular I-O model would be lost. Of the large industrial provinces, Quebec[46] has rectangular I-O tables similar to the Statistics Canada tables, and as such it provides the most promising comparison.[47]

## 1.5 Formal Descriptions of Statistics Canada's Output Determination Model and Price Input-Output Model

The purpose of this section is to briefly set down, in a more formal manner, the Statistics Canada I-O models used in this paper. By providing references to individual, numbered equations belonging to these models, it is hoped to ease the tasks of exposition in the later chapters.

The first model to be examined has been described as the Open Output Determination Model.[48] This model is formulated by defining two functions and combining these with an accounting identity. They are as follows:

$$g = Dq \qquad (1.5.1)$$

In this equation vector $g$ represents the values of industry outputs and vector $q$ the values of domestically produced commodity outputs. Matrix $D$ is referred to as the Domestic Market Share

Matrix. The coefficients in this matrix are calculated by taking the commodities that each industry produces and dividing by the total output of the industry. The equation describes the first assumption, which is that industries will maintain their observed share of the market for each domestically produced commodity irrespective of the levels of commodity production.

The second assumption established the production functions of industries and these then determine the industrial requirements for commodity inputs. The 'industry technology' assumption is as follows:

$$Ui = Bg \qquad (1.5.2)$$

U represents the matrix of commodity inputs while i is a column vector, equal in dimension to the number of industries. Its elements are all equal to 1 . The matrix product Ui represents a vector containing the sum of intermediate inputs of all industries classified by commodity. Matrix B , described as the industry technology matrix, is a matrix of coefficients, each of which is obtained by dividing each element in a column of matrix U (i.e. commodity inputs) by the corresponding total industry output. This equation defines the industry technology assumption such that the values of the inputs of each industry are fixed proportions of the value of the total output of the industry.

The accounting identity states that total supply balances total demand (or dispositions). It is described as follows:

$$q + m + a + v = Bg + \overset{*}{e} + x \qquad (1.5.3)$$

where

- m is a vector of the values of imports
- a is a vector of the value of government production
- v is a vector of the values of withdrawals from inventories

$x$ is a vector of the values of total exports

$\overset{*}{e}$ is a vector of the following final demand categories:

| | |
|---|---|
| PE | represents personal expenditures on goods and services |
| plus FCF | represents fixed capital formation, busines and government |
| plus VPCA | value of physical change in inventories, additions |
| plus GGCE | gross government current expenditures on goods and services. |

Rearranging (1.5.3) yields the following:

$$q = Bg + \overset{*}{e} + x - m - a - v \qquad (1.5.4)$$

Substituting (1.5.2) into (1.5.4) yields the following open determination model.[49]

$$g = (I - DB)^{-1}D\,(\overset{*}{e} + \overset{*}{x} - m - a - v) \qquad (1.5.5)$$

This equation defines the linear transformations of final demand categories into industry outputs. Note that $(\overset{*}{e} + x - m - a - v)$ describes exogenously specified final demand categories. The industry outputs can be obtained by multiplying (1.5.4) by D, substituting (1.5.1) and inverting. Note also that in this formulation of the model there are no leakages out of domestic industries. However, imports, withdrawals from inventories and government production as well as domestic production contribute to the supply of a commodity. These leakages occur out of intermediate as well as out of final demand.

The 'open model', including these leakages, is described as follows:

$$g = [I - D(I - \hat{\mu} - \hat{\alpha} - \hat{\beta})B]^{-1} D [(I - \hat{\mu} - \hat{\alpha} - \hat{\beta})\overset{*}{e} + (I - \hat{\alpha} - \hat{\beta})x] \qquad (1.5.6)$$

where $\hat{\mu}$ is a diagonal matrix of coefficients whose elements are calculated as the ratios of imports to use, when use is defined as $Bg + \overset{*}{e}$

$\hat{\alpha}$ is a diagonal matrix of coefficients whose elements are calculated as the ratio government production to use, use defined as $Bg + \overset{*}{e} + x$

$\hat{\beta}$ is a diagonal matrix of coefficients whose elements are calculated as the ratio of withdrawals to use, use defined as $Bg + \overset{*}{e} + x$

Model (1.5.6) is the form of the model used in the printed I-O tables published in Statistics Canada 15-506E [30], and from which considerable use will be made in Chapters 2 and 3 of this study.

The I-O price model is the 'dual' of the output determination model, for rather than charting the generation of demand through the economic system, the I-O price model charts the propagation of prices through the system. The model is formulated from two basic assumptions.[50] The first assumption specifies the relationship between industry costs and product prices, while the second assumption specifies the cost structure of each industry. In one version of the model, profit margins are assumed to be maintained in real terms (constant dollars). Another version maintains them in current dollars. Both models use price variables which are in index form. The suffix ' after a letter denotes an index.

The first assumption is described by the following equation:

$$p_{q'd} = p'_g D \qquad (1.5.7)$$

In this equation $p_{q'd}$ is a NC order vector of domestically produced commodity price indices and $p_g$ is a NI order vector of industry selling price indices. The matrix D is the Domestic Market share matrix.

The equation states the assumption that a commodity price index is a linear combination of industry selling price indices. The weights of this index are the market share coefficients.

The second equation defines the cost equation. The underlying assumption is that the selling price of an industry is a linear combination of input prices. The latter include intermediate commodities (domestic and imported) and primary inputs. The weights of this index are the appropriate input coefficients. The equation is expressed as follows:

$$p'_g = p_{q'd}(I - \hat{\mu}) B + p'_m \hat{\mu} B + \sum_{i=1}^{NI} p'_{yi} H_i \qquad (1.5.8)$$

In this equation H is a matrix of primary input prices and so $H_i$ is an NY by NI matrix, formed by setting the $i^{th}$ column of $H_i$ equal to the $i^{th}$ column of the matrix $p_y$. As in the open output determination model $\hat{\mu}$ is a diagonal matrix of coefficients whose elements are calculated as the ratios of imports to use. Matrix B is the industry technology matrix.

Substituting (1.5.7) into (1.5.8) yields the following solution for $p'_g$:

$$p'_g = (p'_m\hat{\mu}B + \sum_{i=1}^{NI} p'_{yi}H_i)\,[I - D(I - \hat{\mu})B]^{-1} \qquad (1.5.9)$$

$p_{q'd}$ can then be obtained by substituting (1.5.9) into (1.5.7).

The second form of the model assumes that profit margins are maintained in current dollars. This is stated in the following equation:

$$\pi = p'_g H \qquad (1.5.10)$$

where $\pi$ is a NI order vector of current dollar profit margins and H is the profit row of the H matrix. With this assumption, adjustments have to be made to equation (1.5.8). The new equation is as follows:

$$p'_g = p'_{qd}(I - \hat{\mu})B + p'_m\hat{\mu}B + \sum_{i=1}^{NI} \bar{p}'_{yi}\bar{H}_i + \pi \qquad (1.5.11)$$

In this case $p_y$ and H are obtained by dropping the profit row from $p_y$ and H .

Use of equations (1.5.7), (1.5.10) and (1.5.11) yield the solutions for $p'_g$ , $p'_{qd}$ and $\pi$ . The solution to $p'_g$ , the industry selling price, $p'_{qd}$ the commodity prices, and to $p'_q$, are as follows:

$$p'_g = (p_m + \hat{\mu}B + \sum p_{yi} + H_i + p'_g + \hat{H}\pi) \cdot [I - D(I - \hat{\mu})B]^{-1} \quad (1.5.12)$$

$$p'_{qd} = (p_m + \hat{\mu}B + \sum p_{yi} + H_i + p'_g + \hat{H}\pi) \cdot D[I - D(I - \hat{\mu})B]^{-1} \quad (1.5.13)$$

The two versions of the I-O price model described above are 'cost push' price models. The assumed response of industries to an exogenous change in primary prices, such as an increase in oil import prices, is to adjust their product prices in such a manner so as to offset the increases in costs. Such behaviour is a result of the assumption that changes in the price of inputs do not induce substitution (Equation 1.5.8) and that profit margins are maintained in the face of these increased input prices. These conditions, however, are not sufficient in themselves to establish a one to one relationship between input and output prices. This relationship is also a result of conditions existing in the markets within which industries operate. The demand facing the industries is assumed to be constant and less than infinitely elastic while the supply of the industry is assumed to be infinitely elastic.[51]

## 1.6 Summary

The instrument chosen for the task of analyzing the impact of rising energy costs on Canadian industries is the open I-O price model. Drawn from the set of Statistics Canada I-O models, it provides a realistic insight into the workings of the economy. The assumptions, however, while realistic for large sectors of the economy and acceptable under many conditions, are not applicable to all markets nor can all firms be assumed to rigidly adhere to the specifications of the model.

The I-O price model is a cost push price model in which firms react to increases in their factor prices by passing on the increase by raising their prices. This is an economy where the markets in which industries operate are less than perfectly competitive, where demand is less than infinitely elastic such that firms are able to push up their prices without losing their markets. It is the economy in which firms do not substitute a cheaper for a more expensive input, but instead adhere to their processes of production in which all inputs are employed in rigidly fixed proportions. The response of a firm's prices to an increase in its costs is instantaneous. There are no time lags in response to cost changes; price adjustment in the economy of the I-O model is instantaneous.

A knowledge of the markets of the economy suggests that there are markets which do not approximate to the assumptions of the model. There are parts of the agricultural sector for instance which respond to a cost change by making an adjustment in their production, rather than making a price response.[52] Industries vary in the degrees of their competitiveness. These are variations which can cause different speeds in price responses. If there are substantial shifts in relative input prices, then firms will be attracted to substitute the cheaper for the more expensive input. This will occur at each round of production such that those commodities which embody the more expensive input will be priced

higher than other commodities. The higher priced commodities will be less attractive to the firm than the cheaper commodity, which the firm will be attracted to substitute. The final demand prices of those commodities embodying the more expensive inputs will be affected, and the relative prices of these commodities will in turn elicit a response from the consumer. The strength of this response will affect the demand for the mix of commodities and indirectly the demand for the inputs used in production of the commodity.[53]

These qualifications to the assumptions of the model indicated that a measure of the price response to a change in costs made by the I-O price model is likely to be an overestimate of what is likely to happen. Rather than passing on the cost increase in the form of price rises, industries are likely to engage in substituting a cheaper for a more expensive input, while some may be in too weak a market position to pass on all of the cost increases.

The degree to which the predicted behaviour of prices differs from the observed behaviour is one means of 'testing' the behavioural assumptions of the price I-O model. The usefulness of such an exercise is examined in Chapter 4. This chapter also uses the available I-O models and on these runs a number of energy price simulations. Such exercises require knowledge of the statistical details contained in the I-O tables, for the precision of the commodity aggregations used in the models is crucial to the interpretations of the price simulations. Such information is provided by the following chapter. Chapter 2 also contains a statistical description of the changing demand and supplies for and of the energy commodities in the Canadian economy over the period 1961-71. Except for the last year of this decade, these were years in which the real price of energy fell. They are years which contrast with those of the years 1973-78 when first coal, then natural gas, and then electricity prices rose upwards in the manner set earlier by imported crude oil prices. Predicting the effect that these price changes among the energy commodities will have on the costs of industries from I-O information derived from 1971

tables is a question which will be examined in Chapter 4. Meanwhile, Chapter 3 explores the changes in industrial structures and technology and examines their effects on the consumption of energy over the period 1966-71. In this way, it is hoped to acquire a little insight into the changes in energy intensities and the factors that determine these changes.

## FOOTNOTES - CHAPTER 1

[1]In 1975 the industrial sector, as defined by Statistics Canada, consumed 33 percent of the total energy consumed. The total consumption by the nonresidential sector was 77 percent. See Ellison [15], Chapter I.

[2]This estimate for July 1977 refers to all imported crude oil, and not specifically to the oil from Saudi Arabia. For an analysis of the price information in the oil, natural gas, coal and electricity markets, see Ellison [15].

[3]Canadian oil was initially exempt from the controls.

[4]See E.M.R. [18] page 23.

[5]It was made retroactive back to January 1, 1974.

[6]The policy prior to July 1, 1975, was that each crude received its own compensation rate.

[7]The initial rate in July 1975 was 10 cents per gallon.

[8]National Energy Board, 1976 Annual Report, page 18.

[9]See E.M.R. [18], pages 22 and 147.

[10]For example, see the Hon. A.W. Gillespie, Minister of Energy, Mines and Resources, speech to the Canadian Society of New York, Nov. 16, 1977.

[11]This policy came into effect as of June 20, 1977.

[12]See Ellison [15], Table 2.1.

[13]It should be noted that there is no direct comparison betwen U.S. and Canadian crude prices, for the U.S. average price refers to crude oil which is, on average, of lower quality than Canadian. (The U.S. average is around 33.5 API and 95 sulphur, while Albertan is 38 API and 47 sulphur.) For an analysis of current differences in prices between the U.S. and Canada see Ellison [15], Chapter 3.2.2.

[14]The rationale of the equalization of domestic and international prices is based on the concept of opportunity cost. The opportunity cost of a unit of energy sold in Canada is the alternative value which could be obtained by selling in foreign markets.

[15]See G. Protti [17] for an extensive survey of the differing provincial cost and price structures.

[16]See G. Protti [17] Exhibit 1.1, page 13.

[17]See G. Protti [17] Exhibit 1.1, page 13.

[18]See Table D.2 for further details and for a provincial breakdown.

[19]See G. Protti [17] Table 1.1.

[20]See the Bank of Montreal Business Review, 4th Quarter 1977, the Coal Renaissance. Around 65-70 percent is expected to be produced from uranium plants.

[21]Metallurgical coal cost was $12 a ton on average in 1970, rising to $55 a ton for recent shipment in late 1977. See the Financial Post, Feb. 4, 1977.

[22]In 1975, over 90 percent of Canada's exports were delivered to Japan.

[23]This distinction between the accuracy and comprehensiveness of the price information approximates to the distinction between primary and secondary energy. The prices of the latter, with the notable exception of coal, can be fairly well charted, owing to the fact that prices at the gas and oil well heads are provincially and federally regulated.

[24]The price estimates, as the sources to Table 1.1 indicate, have been taken from the earlier study by Ellison [15]. This paper describes in some detail the methods by which the prices were selected and measured.

[25]See N. Mogil [20].

[26]See The Financial Post, December 17, 1977.

[27]See The Globe and Mail, July 19, 1977.

[28]This province was chosen because some of the available data are broken down on a provincial basis, making national aggregations somewhat difficult. As the country's major manufacturing province, Ontario was selected from among the available provinces.

[29]See Table D.4 where this series is compared with similar indices for the whole of the Canadian economy.

[30]Given the difference in the price increases between capital and labour, of some importance to the energy commodities is whether substitutions took place between them in response to the price differences. The effects on energy of substituting labour for capital would depend largely on the extent to which capital and energy are complementary inputs.

[31]See R. Dorfman [3] for a discussion of the relationship between Leontief's I-O model and Walras' general equilibrium system.

[32]In this definition of the 'open' model the incomes generated in the process of production which accrue to the other sectors are not present. In the 'closed' model, the incomes generated in the process of production accruing to the household sector are spent on goods and services and do not form part of an exogenous final demand. Notice that the terms closed and open are used slightly differently in Chapter 2. In that chapter, open refers to a form of the model in which the leakages created by the government and international trade sector are considered in the calculation of the impact coefficient. In the closed model, these leakages are 'closed', and the impact coefficients are calculated from the closed model.

[33]See Appendix A for a discussion of the implication of this measure. Also see Structual Economic Models: A Users Guide [34] Chapter 4, page 4, for a discussion of the implications of using either current or constant dollar values in I-O models.

[34]We will see in Chapter 2 that the I-O model can also be expressed in physical units, such as BTUs.

[35]These technical coefficients form the 'industry technology matrix'.

[36]In such models the direct energy coefficients are expressed in BTUs per dollar of output. Such a model has been developed by Statistics Canada. See B.C. McInnis [21]. Another form of this model has been developed by R. P. Gupta [46].

[37]I-O statistics are collected on an establishment basis in accordance with the principal-product rule. For example, a plant producing an output mix that includes 50 percent or more paperboard will have all of its inputs and outputs assigned to the sector paperboard mills, although it may actually produce a variety of products.

[38]See H.T. Young [14], page 699, concerning the appropriateness of the cost-push price model as a description of price formation in the agricultural sector.

[39]Statistics Canada now has a set of I-O models. See [34] for details of the particular forms of these models.

[40]Described also as the 'industry technology matrix'.

[41]See Appendix A where the differences in the valuations of output between the I-O model and the census of manufacturing data are discussed. See also Statistics Canada [31].

[42]See R.H. Frank, et al [4].

[43]At the time of writing the latest I-O tables for Canada are for the year 1971.

[44]In the model the 'energy industry', described as "Petroleum Refineries and Coal Products', lumps natural gas, crude mineral oil and coal together. See Melvin [43] for his consideration of these limitations and for his comparison of Ontario with Canadian energy price impacts.

[45]See the U.S. Department of Commerce [35].

[46]See T.I. Matuszewski [10], J. Lefort and R. Marshall [5] and Le Systeme de Comptabilite Economique du Quebec [36].

[47]The Atlantic provinces have also been described by a rectangular model. The aggregations, however, are too large for the purposes of our study. See K. Levitt. [19].

[48]See Statistics Canada Catalogue 15-506E [30], Chapter 4, pages 31-32, and for an earlier and fuller analysis, Statistics Canada Catalogue 15-501 [28], Appendix A, pages 135-364. This model is also described in Structural Economic Models [34], Chapter 4.

[49] $q = [I - BD]^{-1}e$

[50]For an algebraic description of the model, see Statistics Canada [28], Chapter 5, pages 4 - 9. For further treatment of this model type, see R. Rioux [11] and M. Truchon [13].

[51]See H.T. Young [14], pages 690-1 for an exposition of these conditions.

[52]Such markets will be those which are not strongly influenced by coercive marketing boards.

[53]If the chain is continued, changes in demand will affect income and employment levels. However, this particular I-O price model deals only with the impacts on prices. It does not measure the impacts of price changes on income and employment.

CHAPTER 2

# THE DEMAND AND SUPPLY OF ENERGY COMMODITIES IN THE CANADIAN ECONOMY

## 2.1 Introduction

This chapter uses the available I-O tables to analyze the changing picture of the demand for and supply of energy commodities in the Canadian economy. The tables cover a ten year span, from 1961 to 1971, and within this period, information for three years, 1961, 1966 and 1971 has been selected with which to subject the energy commodities to a detailed analysis.

The objective is to examine the demand and supply of both the primary and secondary energy commodities and in doing so to note changes in the sources of supply and in the demand for particular energy commodities. In this way a picture can be built up of the most intensive users of particular energy commodities. This picture will be of use when in the later chapters interpretations are made of the effects of energy price changes on particular industries.

The proceeding section 2.2 introduces definitions of primary and secondary energy commodities and relates these to the aggregations used in the I-O tables. Section 2.3 examines the supply and disposition of the energy commodities. In this section the direct demand for each energy commodity by industry is dealt with in detail, while the proceeding section presents a graphical analysis of the changing direct coefficients for each of the energy commodities. The following section, 2.5, explores the total demand for each energy commodity by industry. The source of this

information is taken from another form of the I-O model, in which the energy commodities are expressed in Btus. The model was closed and was distinct from the published I-O model which was open with import and government production leakages. This closed model allowed estimates to be made of the 1966 total demand for each energy commodity by industry.

## 2.2 Energy Commodities and the Input-Output Tables

The Canadian I-O tables are characterized by their rectangular matrices, in which the number of commodities exceeds the number of industries. In the commodity accounts the supplies of each commodity are registered in columns, and subdivided into the consumption by each domestic industry and the demands of final consumers. In the industry accounts the rows depict the total gross outputs of the industries, classified by commodity. The inputs of any one industry are shown in the industry's column, and are divided into intermediate and primary inputs. Intermediate inputs consist of current account inputs of commodities consumed in the process of production. Primary inputs consist of the following four items: indirect taxes, wages and salaries, surplus (defined as the sum of 'costs' of, or incomes accruing to, capital employed in production in the form of projects and other investment income) and depreciation (the cost of the consumption of the stock of fixed capital employed).[1]

The I-O tables are published in varying degrees of detail.[2] The most detailed table, aggregation L , consists of 595 commodities and 191 industries. However, the published tables are in a more aggregate form. The aggregation designated M is comprised of 91 commodities and 43 industries, while aggregation S consists of 16 industries and 43 commodities.

The immediate interest in these aggregations consists in comprehending the composition of the energy commodities and 'energy' industries. In the aggregation M three 'energy' industries

are used:[3] mineral fuels industry, petroleum and coal products industry and electric power, gas and other utilities. Six commodities are used: coal, crude mineral oils, natural gas, gasoline and fuel oil, other petroleum products and electric power. Aggregation S, as expected, uses a more aggregated set of energy commodities and industries. Three energy commodities are used: mineral fuels, petroleum and coal products and other utilities, while mines, quarries and oil wells, and electric power, gas and other utilities form the two energy industries.

Details of the L and M energy commodity and industry aggregations are shown in Table 2.1. This table is useful in that it shows the relationship between the M and the L aggregations. Note that uranium (i.e. radio-active ores and concentrates) in the L aggregation is lumped into the broader aggregation 'Other Metal Ores and Concentrates' in the M aggregation. Note also how in the M aggregation 'Other Petroleum and Coal Products' contains a number of refined oil commodities from the L aggregation, as well as coke. These M aggregations are of some significance, for in the published tables the commodity aggregations are in the M (and S) aggregations. The L aggregation is not published, with the result that the analysis of the demand and supply of the energy commodities in this chapter is undertaken with the M aggregation.

As has been alluded to earlier, the M aggregation is not the most convenient for the analysis contemplated in this chapter.[4] It would have been useful, for instance, to have been able to reorganize 'Other Petroleum and Coal Products' into a form which would have separated out radio-active ores and concentrates from other metal ores and concentrates. In the case of industries, at the M aggregation level, industry number 31 (Electric Power, Gas and Other Utilities) is of such an aggregation as to make difficult the interpretation of the effects on the electric power industry.

In the analysis a distinction is made between primary and secondary energy. Such a distinction allows observations to be

TABLE 2.1

COMPARISONS OF THE ENERGY INDUSTRY AND
ENERGY COMMODITY AGGREGATIONS USED IN THE I-O TABLES:
'L' AGGREGATION COMPARED WITH 'M' AGGREGATION

| 'L' Commodity Aggregation | | | | 'M' Commodity Aggregation | | |
|---|---|---|---|---|---|---|
| No. | Commodity | L | M | No. | Commodity | L Sequential No. |
| 03300 | Radio Active Ores & Concentrates | 33 | 8 | 8 | Other Metal Ores & Concentrates | 31-33, 35-36 |
| 03700 | Coal | 37 | 9 | 9 | Coal | 37, 40 |
| 03800 | Crude Mineral Oils | 38 | 10 | 10 | Crude Mineral Oils | 38 |
| 03900 | Natural Gas | 39 | 11 | 11 | Natural Gas | 39 |
| 04000 | Other Crude Bituminous Substances | 40 | 9 | 62 | Gasoline & Fuel Oil | 394-396 |
| 39400 | Aviation Gasoline | 394 | 62 | 63 | Other Petroleum & Coal Prod. | 245, 397-402,548 |
| 39500 | Motor Gasoline | 395 | 62 | 78 | Electric Power | 546 |
| 39600 | Fuel Oil | 396 | 62 | 79 | Other Utilities | 547,549 |
| 39700 | Lubricating Oils & Greases | 397 | 63 | | | |
| 39800 | Benzene, Toluene & Xylene | 398 | 63 | | | |
| 39900 | Butane, Propane & Other Liq. Petr. Gas | 399 | 63 | | | |
| 40000 | Naphtha | 400 | 63 | | | |
| 40100 | Asphalt & Coal Oils N.E.S. | 401 | 63 | | | |
| 40200 | Petrochemical Feed Stock | 402 | 63 | | | |
| 54600 | Electric Power | 546 | 78 | | | |
| 54700 | Gas Distribution | 547 | 79 | | | |
| 54800 | Coke | 548 | 63 | | | |
| 54900 | Water & Other Utilities | 549 | 79 | | | |

| 'L' Industry Aggregation | | | | | 'M' Industry Aggregation | | |
|---|---|---|---|---|---|---|---|
| No. | Industry | L | M | 1970 S.I.C. | No. | Industry | L Sequential No. |
| 00500 | Uranium Mines | 5 | 4 | 057 | 4 | Metal Mines | 4-7 |
| 00800 | Coal Mines | 8 | 5 | 061 | 5 | Mineral Fuels | 8-9 |
| 00900 | Petroleum & Gas Wells | 9 | 5 | 064 | 7 | Services Incidental to Mining | 15 |
| 01500 | Services Incidental to Mining | 15 | 7 | 096,098,099 | 25 | Petroleum & Coal Prod Inds. | 121-122 |
| 12100 | Petroleum Refin. | 121 | 25 | 365 | 31 | Electric Power, Gas Other Utilities | 161-163 |
| 12200 | Other Petrol & Coal Prod. Ind. | 122 | 25 | 369 | | | |
| 16100 | Electric Power | 161 | 31 | 9 | | | |
| 16200 | Gas Distribution | 162 | 31 | 9 | | | |
| 16300 | Water & Other Utilities | 163 | 31 | 9 | | | |

SOURCE: Statistics Canada Catalogue No. 15-506E, Occasional [30] : Aggregation Parameters for the I-O tables. pages 33-48.

made of the effects of energy commodities on the structure of the economy as represented by the industrial aggregations used in the I-O model. Primary energy commodities include coal, crude mineral oil, natural gas, hydro electricity and uranium.[5] Secondary energy commodities include coke, gasoline and fuel oil, other petroleum and coal products and thermal generated electricity. These distinctions are not always possible to maintain, partly for the reasons given earlier, where the definitions of these commodities were discussed, and also because of the difficulty and arbitrariness which is sometimes involved in converting secondary energy back to primary energy. Some of these difficulties in differentiating between commodities occur in the next two subsections. Where they occur, the meaning of primary and secondary energy is redefined. Finally, it should be emphasized that in depicting change over the period examined use has not been made of all the years between 1961 to 1971, but instead to the years 1961, 1966 and 1971. These years not only represent a convenient time span, but they are also years when important statistical censuses were taken.

## 2.3 The Supply and Disposition of Energy Commodities

The I-O tables express an accounting balance between total supply and total disposition (demand). The composition of each side of the equation provides insights into the commodities and industries. Information such as the share of domestic output in the total output of a commodity and the share of private personal consumption in the total disposition of a commodity can be readily obtained from the data in the published tables. This section shall be primarily concerned with the supply and demand characteristics of the energy commodities, and the relationship of these characteristics to all other commodities in the tables.

Central to the analysis are the relationships of the constituent forms of the accounting balance between total supply and total disposition. The equations have been specified as follows.[6]

Total Supply = value of domestically produced commodity outputs
+ value of imports
+ value of government production
+ withdrawals from the value of inventories
= Total Disposition
= value of total intermediate inputs
+ total exports
+ personal expenditures on goods and services
+ fixed capital formation, business and government
+ value of physical changes in inventories, additions
+ gross government current expenditures on goods and services. (2.3.1)[7]

Of particular interest is the composition of the supply of energy commodities. Table 2.2 explores these relationships by relating the sources of energy supply of the commodities to total supply. Hence, the rows contain the commodities, the columns the values of the quantities supplied and the percentages that these quantities represent of total supply. The figures show all energy commodity supplies increasing in value over the decade 1961 to 1971. Domestic output as a percentage of total supply was largest for electricity (over 99 percent in 1971) and smallest for coal (28.7 percent in 1971). It will be recalled that we are dealing with supply, and so imports and not exports enter the supply side of the identity. In fact, imports accounted for 61 percent of the total supply of coal in 1971, but only 0.4 percent of the electricity supply. Government production also enters the supply

TABLE 2.2

ENERGY COMMODITIES: SOURCES OF SUPPLY EXPRESSED AS PERCENTAGES OF TOTAL SUPPLY
1961, 1966 AND 1971

| Commodity/Supply | Domestically Produced | | Imports | | Government Production | | Withdrawals from Inventories | | Total Supply | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $M | % | $M | % | $M | % | $M | % | $M | %[a] |
| **Coal** | | | | | | | | | | |
| 1961 | 42.5 | 24.6 | 119.4 | 69.2 | -- | | 10.6 | 6.1 | 172.5 | 100.0 |
| 1966 | 50.1 | 23.1 | 166.5 | 76.8 | -- | | -- | | 216.6 | 100.0 |
| 1971 | 100.4 | 28.7 | 213.2 | 60.9 | 23.2 | 6.6 | 13.0 | 3.7 | 349.8 | 100.0 |
| **Crude Mineral Oils** | | | | | | | | | | |
| 1961 | 524.6 | 58.7 | 367.9 | 41.2 | -- | | -- | 0.1 | 897.5 | 100.0 |
| 1966 | 862.5 | 67.7 | 407.7 | 32.0 | -- | | 2.2 | 0.2 | 1272.4 | 100.0 |
| 1971 | 1495.5 | 68.2 | 692.1 | 31.5 | -- | | 5.3 | 1.1 | 2192.9 | 100.0 |
| **Natural Gas** | | | | | | | | | | |
| 1961 | 68.3 | 95.0 | 2.8 | 3.8 | -- | | 0.8 | | 71.9 | 100.0 |
| 1966 | 164.6 | 89.7 | 18.8 | 10.2 | -- | | -- | | 183.4 | 100.0 |
| 1971 | 318.8 | 98.0 | 6.3 | 2.0 | -- | | -- | | 325.1 | 100.0 |
| **Gasoline & Fuel Oil** | | | | | | | | | | |
| 1961 | 1057.8 | 91.0 | 104.7 | 9.0 | 0.1 | -- | -- | | 1162.6 | 100.0 |
| 1966 | 1291.5 | 88.8 | 161.1 | 11.1 | 0.6 | -- | -- | | 1453.2 | 100.0 |
| 1971 | 1847.4 | 91.7 | 166.3 | 8.2 | -- | | -- | | 2013.7 | 100.0 |
| **Other Petroleum & Coal Products** | | | | | | | | | | |
| 1961 | 205.4 | 79.3 | 53.3 | 20.6 | -- | | -- | | 258.7 | 100.0 |
| 1966 | 293.0 | 78.0 | 82.3 | 22.0 | -- | | -- | | 375.3 | 100.0 |
| 1971 | 405.1 | 80.0 | 94.0 | 18.5 | 8.2 | 1.6 | -- | | 507.3 | 100.0 |
| **Electricity** | | | | | | | | | | |
| 1961 | 878.7 | 99.7 | 1.4 | 0.1 | 1.0 | 0.1 | -- | | 881.1 | 100.0 |
| 1966 | 1223.6 | 99.0 | 10.2 | 0.8 | 1.3 | 0.1 | -- | | 1235.1 | 100.0 |
| 1971 | 2024.3 | 99.4 | 8.0 | 0.4 | 2.9 | 0.1 | -- | | 2035.2 | 100.0 |

SOURCE: Statistics Canada Catalogue 15-506E [2], Tables 6 and 7 and 47, 86 and 87.

NOTE: [a]Percentages do not add exactly to 100 due to rounding.

side. Although this is a small category for most energy commodities, in 1971 it accounted for 6.6 percent of total coal supplies.[8]

Table 2.3 depicts the domestically produced energy commodities as a percentage of all energy output produced in Canada. The figures are derived from Table 2.2, column 1. Over the decade the shares remained fairly constant, with coal and electricity losing some ground, while the largest gainers were crude mineral oils and natural gas. A similar picture emerges from Table 2.4, which shows for each prime energy commodity the percentage which each occupies of the total supplied in 1961, 1966 and 1971.

Turning to demand for the energy commodities, two distinct forms of demand are considered. The first refers to the direct demand for an energy commodity used in the production of the output of an industry. The second refers to the total demand for an energy commodity used in the production of the output of an industry.

For example, in producing chemicals, the chemical industry will purchase natural gas directly in order to manufacture the chemicals. There will also be an indirect demand for natural gas, which will be the natural gas purchased by all industries in which production is required in order to supply inputs used in the chemical industry. The total demand for natural gas consists of the aggregation of the direct and indirect demand. In this and the following sectors the direct demand for each energy commodity will be examined. Section 2.5 is devoted to an analysis of the total demands for energy commodities.

The information which is readily available from the I-O tables refers to the direct demand for energy commodities by industries. By taking each energy commodity in turn the demand or disposition side of equation 2.3.1 can be examined. Table 2.5 displays the intermediate and final demand sectors direct requirements for the six energy commodities. The years chosen are again 1961, 1966 and 1971. Details of the contents of the six demand sectors are given in the footnote to Table 2.5.

TABLE 2.3

ENERGY COMMODITIES PRODUCED IN CANADA:
ENERGY COMMODITIES AS A PERCENTAGE OF ALL ENERGY
OUTPUT PRODUCED IN CANADA
($ PRODUCERS' PRICES, CURRENT $)

| Commodities | 1961 | 1966 | 1971 |
|---|---|---|---|
| Coal | 2.8 | 2.2 | 2.5 |
| Crude Mineral Oils | 34.6 | 37.5 | 38.0 |
| Natural Gas | 4.6 | 7.1 | 8.1 |
| Electric Power | 58.0 | 53.2 | 51.4 |
| Total Output of Energy Commodities | 100.0 | 100.0 | 100.0 |

SOURCE: See Table 2.2

TABLE 2.4

ENERGY COMMODITIES SUPPLIED IN CANADA:
ENERGY COMMODITIES AS A PERCENTAGE OF ALL ENERGY
SUPPLIED TO CANADA
($ PRODUCERS' PRICES, CURRENT $)

| Commodities | | 1961 | 1966 | 1971 |
|---|---|---|---|---|
| Coal | | 8.5 | 7.4 | 7.1 |
| Crude Mineral Oils | | 44.2 | 43.7 | 44.7 |
| Natural Gas | | 3.6 | 6.3 | 6.6 |
| Electric Power | | 43.6 | 42.5 | 41.5 |
| Total Output of Energy Commodities | % | 100.0 | 100.0 | 100.0 |
| | $M | 2018.0 | 2907.5 | 4903.0 |

SOURCE: See Table 2.2, the column of total supply.

NOTE: The percentages do not add exactly to a hundred due to rounding.

TABLE 2.5

INTERMEDIATE AND FINAL DEMAND SECTORS' DIRECT REQUIREMENTS OF ENERGY COMMODITIES: 1961, 1966 AND 1971
(Producers' Prices, Current $)

| Commodity/Demand[c] | | Intermediate Demand | | Exports | | Personnel Expenditure on Goods & Services | | Value of Physical Changes in Inventories (Additions) | | Govt. Gross Current Exp. on Goods & Services | | Total Demand | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $M | % of T.D. | $M | % of T.D. | $M | % of T.D. | $M | % of T.D. | $M | % of T.D. | $M | %[a] |
| Coal | 1961 | 126.5 | 73.3 | 8.0 | 4.6 | 24.7 | 14.3 | 3.9 | 2.2 | 9.4 | 5.4 | 172.5 | 100.0 |
| | 1966 | 174.3 | 80.4 | 14.3 | 6.6 | 11.5 | 5.3 | 4.8 | 2.2 | 11.7 | 5.4 | 216.6 | 100.0 |
| | 1971 | 245.7 | 70.2 | 77.9 | 22.2 | 11.8 | 3.3 | - | - | 14.4 | 4.1 | 349.8 | 100.0 |
| Crude Mineral Oils | 1961 | 726.3 | 81.3 | 162.6 | 18.2 | - | - | 3.6 | 0.4 | - | - | 892.5 | 100.0 |
| | 1966 | 950.7 | 74.7 | 321.7 | 25.2 | - | - | - | - | - | - | 1272.4 | 100.0 |
| | 1971 | 1429.1 | 65.1 | 763.8 | 34.8 | - | - | - | - | - | - | 2192.9 | 100.0 |
| Natural Gas | 1961 | 24.4 | 33.9 | 21.1 | 29.3 | 24.2 | 33.6 | - | - | 2.2 | 3.0 | 71.9 | 100.0 |
| | 1966 | 63.2 | 34.4 | 60.8 | 33.1 | 50.4 | 27.4 | 1.6 | 0.8 | 7.4 | 4.0 | 183.4 | 100.0 |
| | 1971 | 99.8 | 30.6 | 142.0 | 43.6 | 70.4 | 21.6 | 0.8 | 0.2 | 12.1 | 3.7 | 325.1 | 100.0 |
| Gasoline & Fuel Oil | 1961 | 584.1 | 50.2 | 5.1 | 0.4 | 494.6 | 42.5 | 20.5 | 1.7 | 58.3 | 5.0 | 1162.6 | 100.0 |
| | 1966 | 752.9 | 51.8 | 8.3 | 0.5 | 599.8 | 41.2 | 19.3 | 1.3 | 72.9 | 5.0 | 1453.2 | 100.0 |
| | 1971 | 950.7 | 47.2 | 49.1 | 2.4 | 857.7 | 42.6 | 50.5 | 2.5 | 105.7 | 5.2 | 2013.7 | 100.0 |
| Other Petroleum & Coal Products | 1961 | 219.0 | 84.6 | 9.1 | 3.5 | 26.7 | 10.3 | 1.2 | 0.4 | 2.7 | 1.0 | 258.7 | 100.0 |
| | 1966 | 303.7 | 80.9 | 23.0 | 6.1 | 36.6 | 9.7 | 7.7 | 2.0 | 4.3 | 1.0 | 375.3 | 100.0 |
| | 1971 | 405.8 | 79.9 | 58.9 | 11.6 | 34.3 | 6.7 | 3.0 | 0.6 | 5.3 | 1.0 | 507.3 | 100.0 |
| Electricity | 1961 | 440.1 | 49.9 | 14.7 | 1.6 | 365.8 | 41.5 | - | - | 60.5 | 6.8 | 881.1 | 100.0 |
| | 1966 | 642.7 | 52.0 | 15.9 | 1.2 | 474.6 | 38.4 | - | - | 101.9 | 8.2 | 1235.1 | 100.0 |
| | 1971 | 962.8 | 47.3 | 43.0 | 2.1 | 836.5 | 41.1 | - | - | 192.9 | 9.4 | 2035.2 | 100.0 |

SOURCES: Statistics Canada Catalogue 15-506E [30], Tables 6 and 7, 46 and 47, and 86 and 87.

NOTES: [a]Totals do not exactly add to 100.0 due to rounding.
[b]The various demand categories consist of the following six items: domestic exports, re-exports; personnel expenditures on goods and services, consumers expenditures on durable goods, consumers expenditures on semi-durable goods and consumers expenditures on services.
[c]The column for fixed capital formation has been excluded because none was recorded for any of the energy commodities.

In the case of coal, the intermediate demand rose in 1966 to over 80 percent of the total demand, only to drop down to 70 percent by 1971. Note, however, the rise in exports, from less than 5 percent in 1961 to over 22 percent in 1971. Crude mineral oils have also experienced a fall in the share demanded from the intermediate sector, from 81 to 65 percent, and similarly this has coincided with a rise in exports, from 18 to 34 percent. Natural gas has experienced a large jump in exports, up to 43 percent in 1971, while personal consumption as a percentage dropped back down to 21 percent. Gasoline and fuel oil displayed the highest percentage accounted for by personal expenditures, with an average of around 42 percent for the three years. Other petroleum and coal products had, not unexpectedly, the highest percentage of all the commodities demanded directly by the intermediate sector, with 80 percent in 1971. Electricity had a constant share going to intermediate demand, at around 50 percent, while personal expenditure was around the 40 percent mark.

The growth in consumption over the periods 1961/66 and 1966/71 and 1961/71 is given for each energy commodity in Table 2.6 and the prices are in current dollars. The distinction between 'prime' energy[9] commodities and 'secondary energy' commodities has been retained for this table. With the exception of natural gas, the period of rapid growth was that from 1966-71, although as the average for the whole ten year period indicates, these five years were not necessarily those during which the growth rates in consumption were the highest. Taking the ten year average growth figures, natural gas had the highest average growth rate, while the group 'Other Petroleum & Coal Products' had the lowest.

Tables 2.7 to 2.10 display in more detail the intermediate demands for energy commodities. In doing so they enumerate the direct demand for energy commodity inputs by 43 industries at the M level of aggregation. In order to closely identify the large energy users, industries have been ranked by their percentage share

TABLE 2.6

GROSS CANADIAN ENERGY CONSUMPTION 1961-71
(PRODUCERS' PRICES, CURRENT $)

| Energy Commodity | Total Consumption $M | | | Average Rate of Growth % | | |
|---|---|---|---|---|---|---|
| | 1961 | 1966 | 1971 | 1961-66 | 1966-71 | 1961-71 |
| 1 Coal | 172.5 | 216.6 | 349.9 | 5.1 | 26.4 | 17.6 |
| 2 Crude Mineral Oil | 892.5 | 1272.4 | 2192.9 | 8.5 | 14.4 | 14.5 |
| 3 Natural Gas | 71.9 | 183.4 | 325.1 | 31.0 | 15.4 | 35.2 |
| 4 Electricity | 881.1 | 1235.1 | 2035.2 | 8.0 | 12.9 | 13.1 |
| Subtotal 1-4 | 2018.0 | 2907.5 | 4903.0 | 8.8 | 13.7 | 14.2 |
| 5 Gasoline & Fuel Oil | 1162.6 | 1453.2 | 2013.7 | 5.0 | 7.7 | 7.3 |
| 6 Other Petroleum & Coal Products | 258.7 | 375.3 | 507.3 | 9.0 | 7.0 | 9.6 |
| Subtotal 5-6 | 1421.3 | 1828.5 | 2521.0 | 5.7 | 7.5 | 7.7 |
| GRAND TOTAL | 3439.3 | 4736.0 | 7424.0 | 7.5 | 11.3 | 11.6 |

SOURCE: Table 2.5, the Total Demand Column.

TABLE 2.7

DIRECT USE OF COAL AMONG CANADIAN INDUSTRIES, 1961, 1966 AND 1971
(Producers' Prices, Current $)

| 1961 | | | 1966 | | | 1971 | | |
|---|---|---|---|---|---|---|---|---|
| Ind. No.[a] | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % |
| 19 | 56.6 | 44.7 | 19 | 65.1 | 37.3 | 19 | 106.6 | 43.3 |
| 17 | 19.4 | 60.0 | 31 | 41.3 | 61.2 | 31 | 104.9 | 85.9 |
| 26 | 9.2 | 67.2 | 17 | 18.4 | 71.7 | 17 | 8.4 | 89.3 |
| 31 | 7.8 | 73.3 | 26 | 12.7 | 78.9 | 28 | 7.4 | 92.3 |
| 24 | 7.7 | 79.3 | 24 | 10.4 | 84.8 | 24 | 3.9 | 93.8 |
| 8 | 5.6 | 83.7 | 22 | 4.2 | 87.2 | 22 | 2.8 | 94.8 |
| 29 | 3.5 | 86.4 | 29 | 2.8 | 88.8 | 26 | 2.7 | 95.9 |
| 22 | 3.0 | 88.7 | 8 | 2.5 | 90.2 | 25 & 29 | 1.6 | 97.1 |
| Total[b] | 112.8 | | | 157.4 | | | 239.9 | |
| Grand Total | 126.5 | | | 174.3 | | | 245.7 | |

SOURCE: The Input-Output Structure of the Canadian Economy 1961-71. Cat. 15-506E Occasional [2].
1961 - Table 6, pages 54-59
1966 - Table 46, pages 185-90
1971 - Table 86, pages 310-315

NOTES: [a] Key to the industry numbers used in the table:

| Ind. No. | Industry Title |
|---|---|
| 19 | Primary Metal Industries |
| 17 | Paper and Allied Industries |
| 26 | Chemical and Chemical Producing Inds. |
| 31 | Electrical Power, Gas and Other Utilities |
| 24 | Non Metal Minimal Prod. Ind. |
| 8 | Food and Beverage Industries |
| 29 | Transportation and Storage |
| 22 | Transport Equipment Industries |
| 25 | Petroleum and Coal Products Industries |

[b] Totals do not add up exactly due to rounding.

TABLE 2.8

DIRECT USE OF NATURAL GAS AMONG CANADIAN INDUSTRIES, 1961, 1966 AND 1971
(Producers' Prices, Current $)

| 1961 | | | 1966 | | | 1971 | | |
|---|---|---|---|---|---|---|---|---|
| Ind. No.[a] | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % |
| 33 | 5.5 | 22.5 | 33 | 10.8 | 17.0 | 33 | 13.8 | 13.8 |
| 17 | 2.6 | 33.1 | 29 | 7.4 | 28.7 | 26 | 11.9 | 25.7 |
| 26 | 2.3 | 42.5 | 19 & 26 | 5.5 | 46.1 | 29 | 10.7 | 36.4 |
| 35 | 2.2 | 51.5 | 35 | 5.1 | 54.1 | 17 | 8.9 | 45.3 |
| 24 | 2.0 | 59.6 | 24 | 4.1 | 60.5 | 19 | 8.6 | 53.9 |
| 19 | 1.8 | 66.9 | 17 | 3.9 | 66.6 | 24 | 7.2 | 61.1 |
| 29 | 1.6 | 73.4 | 8 | 3.5 | 72.1 | 8 | 4.7 | 65.8 |
| 20 | 0.8 | 76.6 | 31 | 3.3 | 77.3 | 31 | 4.1 | 69.9 |
| 25 | 0.8 | 79.8 | 20 | 2.1 | 80.6 | 22 | 2.5 | 72.4 |
| | | | | | | 20 | 2.2 | 74.6 |
| | | | | | | 32 & 39 | 1.9 | 78.4 |
| | | | | | | 4 | 1.8 | 80.2 |
| Total[b] | 19.6 | | | 51.2 | | | 80.2 | |
| Grand Total | 24.4 | | | 63.2 | | | 99.8 | |

SOURCE: The Input-Output Structure of the Canadian Economy 1961-71, Cat. 15-506E Occasional [2].
1961 - Table 6, pages 54-59; 1966 - Table 46, pages 185-90; 1971 - Table 86, pages 310-315.

NOTES: [a] Key to the industry numbers used in the table:

| Ind. No. | Industry Title |
|---|---|
| 33 | Retail Trade |
| 17 | Paper and Allied Industries |
| 26 | Chemical & Chemical Products Inds. |
| 35 | Finance, Insurance & Real Estate |
| 24 | Non-Metal Mineral Prod. Inds. |
| 31 | Electric Power, Gas & Other Utilities |
| 32 | Wholesale Trade |
| 19 | Primary Metal Industries |
| 29 | Transportation and Storage |
| 20 | Metal Fabricating Industries |
| 25 | Petroleum & Coal Products Industries |
| 8 | Food & Beverage Industries |
| 22 | Transport Equipment Industries |
| 39 | Accommodation, Food Services |
| 4 | Metal Mines |

[b] Totals do not add up exactly due to rounding.

TABLE 2.9

DIRECT USE OF GASOLINE AND FUEL OIL AMONG CANADIAN INDUSTRIES 1961, 1966 AND 1971
(Producers' Prices, Current $)

| 1961 | | | 1966 | | | 1971 | | |
|---|---|---|---|---|---|---|---|---|
| Ind. No.[a] | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % |
| 29 | 132.4 | 22.6 | 29 | 165.2 | 21.9 | 29 | 241.2 | 25.3 |
| 1 | 131.2 | 45.0 | 1 | 139.9 | 40.4 | 1 | 161.1 | 42.2 |
| 28 | 67.9 | 56.6 | 28 | 91.1 | 52.4 | 28 | 64.4 | 48.9 |
| 32 | 30.1 | 61.7 | 32 | 37.8 | 57.4 | 32 | 57.7 | 54.9 |
| 8 | 27.1 | 66.3 | 8 | 35.9 | 62.1 | 17 | 56.8 | 60.8 |
| 43 | 24.0 | 70.4 | 17 | 33.8 | 66.5 | 33 | 46.0 | 65.6 |
| 33 | 23.7 | 74.4 | 33 | 29.8 | 70.4 | 43 | 42.9 | 70.1 |
| 2 | 18.1 | 77.4 | 19 | 23.3 | 73.4 | 31 | 27.8 | 73.0 |
| 17 | 16.5 | 80.2 | 43 | 23.0 | 76.4 | 8 | 24.3 | 75.5 |
| | | | 2 | 22.1 | 79.3 | 19 | 22.8 | 77.8 |
| | | | 31 | 14.3 | 81.1 | 4 | 20.9 | 79.9 |
| Total[b] | 471.0 | | | 616.2 | | | 765.9 | |
| Grand Total | 584.1 | | | 752.9 | | | 950.7 | |

SOURCE: The Input-Output Structure of the Canadian Economy 1961-71, Cat. 15-506E Occasional [2].
1961 - Tabel 6, pages 54-59; 1966 - Table 46, pages 185-190; 1971 - Table 86, pages 310-315.

NOTES: [a] Key to the industry numbers used in the table:

| Ind. No. | Industry Title |
|---|---|
| 29 | Transport. & Storage |
| 1 | Agriculture |
| 28 | Construction Industry |
| 32 | Wholesale Trade |
| 8 | Food & Beverage Industries |
| 43 | Travel Promotion & Advert. |
| 33 | Retail Trade |
| 2 | Forestry |
| 17 | Paper & Allied Industries |
| 31 | Electric Power, Gas & Other Utilities |
| 4 | Metal Mines |

[b] Totals do not add up exactly due to rounding.

TABLE 2.10

DIRECT USE OF OTHER PETROLEUM AND COAL PRODUCTS AMONG CANADIAN INDUSTRIES 1961, 1966 AND 1971
(Producers' Prices, Current $)

| 1961 | | | 1966 | | | 1971 | | |
|---|---|---|---|---|---|---|---|---|
| Ind. No.[a] | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % |
| 26 | 51.8 | 23.6 | 26 | 72.1 | 23.7 | 26 | 103.1 | 25.4 |
| 28 | 48.6 | 45.7 | 28 | 72.0 | 47.4 | 28 | 88.9 | 47.3 |
| 19 | 26.6 | 57.8 | 19 | 34.6 | 58.7 | 19 | 50.7 | 59.7 |
| 1 | 19.5 | 66.7 | 1 | 26.5 | 67.4 | 1 | 35.6 | 68.4 |
| 17 | 10.9 | 71.6 | 25 | 14.5 | 72.1 | 25 | 17.1 | 72.6 |
| 25 | 10.1 | 76.2 | 17 | 13.9 | 76.6 | 29 | 17.0 | 76.7 |
| | | | 29 | 11.3 | 80.3 | 17 | 15.8 | 80.5 |
| Total[b] | 167.5 | | | 245.0 | | | 328.2 | |
| Grand Total | 219.0 | | | 303.7 | | | 405.8 | |

SOURCE: The Input-Output Structure of the Canadian Economy 1961-71, Cat. 15-506E Occasional [2].
1961 - Table 6, pages 54-59; 1966 - Table 46, pages 185-190; 1971 - Table 86, pages 310-315.

NOTES: [a] Key to the industry numbers used in the table:

| Ind. No. | Industry Title |
|---|---|
| 26 | Chemical & Chemical Prod. Ind. |
| 28 | Construction Industry |
| 19 | Primary Metal Industries |
| 1 | Agriculture |
| 17 | Paper & Allied Industries |
| 25 | Petroleum & Coal Products Industry |
| 29 | Transport. & Storage |

[b] Totals do not add up exactly due to rounding.

of the total of the energy commodities used. The three years studied give some indication of the possible shift among industries in the demands for the energy commodities. Such intepretations that are made, however, need to take heed of the fact that own generated energy commodities are excluded from the tables.[10] Such exclusions are likely to underestimate the energy consumption of those industries generating considerable amounts of energy, such as the prime metal industries, the constituent industries of which generate considerable quantities of electricity.

In the case of coal (Table 2.7), eight industries (directly) used almost 90 percent of coal in 1961, a percentage which increased to almost 98 percent in 1971.[11] The top industrial consumer in all three years was the primary metal industry, an industry which used coal primarily as a raw material in the iron producing process as distinct from its use as a source of energy.[12] Note the rise in importance of the electric power, gas and other utilities in 1971, indicating the importance of coal as an input in the generation of electricity.

The table for natural gas (Table 2.8) depicts for 1971 usage among a large number of industries, only electricity exceeding it in number. Industry 33, retail trade, is shown to be the largest user, while chemical and chemical product industries, miscellaneous manufacturing industries and the paper and allied industries are also large users. The direct use of gasoline and fuel oil (Table 2.9) is similarly characterised by a growing number of users over time. Still of growing importance is the transport and storage industry. Along with agriculture and the construction industry, these three accounted for almost 50 percent of direct demand in 1971.

The commodity group 'Other Petroleum and Coal Products' is characterized by a high concentration among three industries: chemical and chemical products industries, the construction industry and the primary metal industries. These accounted for almost 60 percent of demand in 1971. In contrast, the last table

of this series (Table 2.11) shows that in 1971 some fifteen industries accounted for 80 percent of the demand for electricity. The largest users were the paper and allied industries.

These tables (Tables 2.7 to 2.11) show three manufacturing industries as large direct consumers of energy. They are the paper and allied industries, the primary metal industries and the chemical and chemical products industries. The statistics of the manufacturing industries provide a means of identifying the large consumers of energy, as well as indicating the geographical location of the industries. In Appendix A, such an exercise has been undertaken. This Appendix also contains an examination of the differences in the valuation procedures adopted in the census of manufacturing information and those in the I-O tables. As a result of this analysis, seven manufacturing industries are seen to be the major industrial consumers of energy.[13] They are: iron and steel mills, smelting and refining industries, pulp and paper mills, cement manufacturers, glass manufacturers, manufacturers of industrial chemicals (inorganic) and industrial chemicals (organic). The division of the consumption of each energy commodity by these industries by province[14] shows Central Canada (Ontario and Quebec) to be the major energy consuming region. Only in the consumption of natural gas and electricity in the production of industrial chemicals did the prairie provinces make a significant showing. Pulp and paper mills located in B.C. appeared as important consumers of gasoline and fuel oil and electricity.

Before leaving the identification of direct energy users, two useful notes can be made about mineral oils and the consumption of commodities by those industries producing the energy commodities. The energy commodity group 'Crude Mineral Oils' has not been tabulated because almost all is consumed by the other petroleum and coal products industry. In 1971 this industry accounted for 75 percent of the output of other petroleum and coal products,[15] and in turn consumed 4.2 percent of the total domestic output. The industry 'electric power, gas and other utilities', which accounted

TABLE 2.11

DIRECT USE OF ELECTRICITY AMONG CANADIAN INDUSTRIES, 1961, 1966 AND 1971
(Producers' Prices, Current $)

| 1961 | | | 1966 | | | 1971 | | |
|---|---|---|---|---|---|---|---|---|
| Ind. No.[a] | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % | Ind. No. | $ Million | Cumulative % |
| 17 | 62.6 | 14.2 | 33 | 96.0 | 14.9 | 17 | 117.3 | 12.1 |
| 33 | 58.2 | 27.4 | 17 | 82.7 | 27.7 | 33 | 114.0 | 23.9 |
| 19 | 41.1 | 36.7 | 19 | 56.1 | 36.4 | 19 | 86.4 | 32.8 |
| 1 | 22.7 | 41.8 | 1 & 26 | 37.0 | 47.8 | 35 | 61.1 | 39.1 |
| 26 | 25.6 | 47.6 | 4 | 35.1 | 53.7 | 26 | 58.4 | 45.1 |
| 4 | 22.0 | 52.5 | 8 | 27.8 | 58.0 | 4 | 56.7 | 50.9 |
| 8 | 20.5 | 57.1 | 35 | 23.9 | 61.7 | 1 | 41.9 | 55.2 |
| 29 | 15.3 | 60.5 | 32 | 22.7 | 65.2 | 39 | 37.0 | 59.0 |
| 32 | 15.2 | 63.9 | 29 | 21.4 | 68.5 | 8 | 35.6 | 62.5 |
| 24 | 15.1 | 67.3 | 24 | 20.3 | 71.6 | 29 | 35.3 | 66.2 |
| 35 | 14.4 | 70.5 | 31 | 19.9 | 74.6 | 31& 32 | 29.5 | 72.2 |
| 31 | 13.6 | 73.5 | 5 | 16.6 | 77.1 | 5 | 27.2 | 75.0 |
| 5 | 12.0 | 76.2 | 22 | 13.7 | 79.2 | 24 | 25.6 | 77.5 |
| 15 | 9.5 | 78.3 | 15 | 12.9 | 81.2 | 22 | 23.2 | 80.0 |
| 20 | 8.5 | 80.2 | | | | | | |
| Total[b] | 356.3 | | | 523.1 | | | 778.7 | |
| Grand Total | 440.1 | | | 642.7 | | | 962.8 | |

SOURCE: The Input-Output Structure of the Canadian Economy 1961-71, Cat. 15-506E Occasional (2).
1961 - Table 6, pages 54-59; 1966 - Table 46, pages 185-190; 1971 - Table 86, pages 310-315.

NOTES: [a] Key to industry numbers used in the table:

| Ind. No. | Industry Title |
|---|---|
| 17 | Paper & Allied Industries |
| 33 | Retail Trade |
| 19 | Primary Metal Industry |
| 1 | Agriculture |
| 26 | Chemical & Chemical Products Industries |
| 4 | Metal Mines |
| 8 | Food & Beverage Industries |
| 29 | Transport. & Storage |
| 32 | Wholesale Trade |
| 24 | Non-Metal Mineral Products Industry |
| 35 | Finance, Insurance & Real Estate |
| 31 | Electric Power, Gas, Other Utilities |
| 5 | Mineral Fuels |
| 15 | Wood |
| 20 | Metal Fabricating Industries |
| 39 | Accommodation, Food Services |

[b] Totals do not add up exactly due to rounding.

for 98 percent of the electricity generated in 1971 also consumed 3.0 percent of its own output in 1971. These were the two largest industrial consumers of their own produced energy. In the case of the 'other petroleum and coal products' industry, the high percentage suggests that a large amount is used not as energy but as feedstock.

## 2.4 Direct Energy Coefficients: 1961 Compared With 1971

The preceding section included a detailed description of the direct consumption of the energy commodities by industries over the period 1961 to 1971. This section extends this description by measuring and displaying the direct energy coefficients in the years 1961 to 1971.

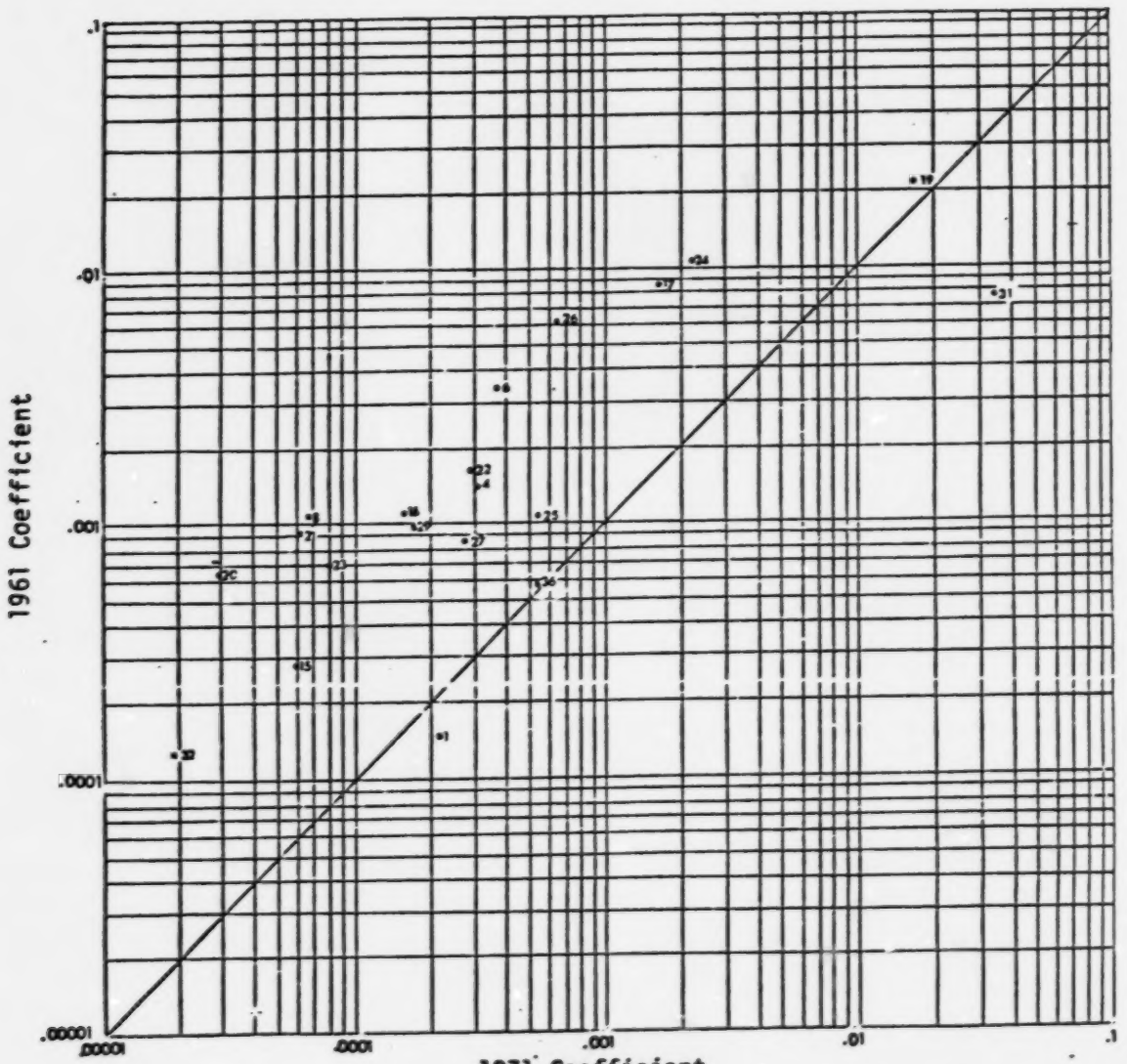
A direct energy coefficient refers to the direct amount of energy needed to produce a unit of output of a particular industry. As the unit of measurement is in dollars, then the direct coal coefficient in the steel industry is the value of the coal directly required to produce a dollar's worth of steel. A measure of total energy used in producing a dollar's worth of output of an industry involves direct plus indirect energy inputs. The former are often large relative to the latter, such that the direct coefficients can provide a useful indication of the total energy required to produce a unit of output. Sometimes, however, the reverse is the case. Furthermore, over time, while the direct energy coefficient may decline, the indirect energy coefficient increases. In such situations, movements in direct energy coefficients fail to indicate movements in total energy requirements. For example, the direct demands in the clothing industry for fuel oil may decline as electricity usage increases, but at the same time the industry may increase its use of synthetic fibres. The latter involve a considerable amount of chemicals, which in turn are often derived from oil based products. While the direct oil coefficient declines, the indirect coefficient increases.

This illustration is presented to underline the descriptive nature of this section. It presents a description of the direct energy coefficients by industries.

The energy commodities examined are those included in the published tables, and are at the M level of aggregation. They are the following commodities: coal, electricity, gasoline and fuel oil, natural gas and other petroleum and coal products. The coefficients are expressed in constant dollars, 1961 prices, and were derived from Statistics Canada Catalogue 15-507E Occasional [29].

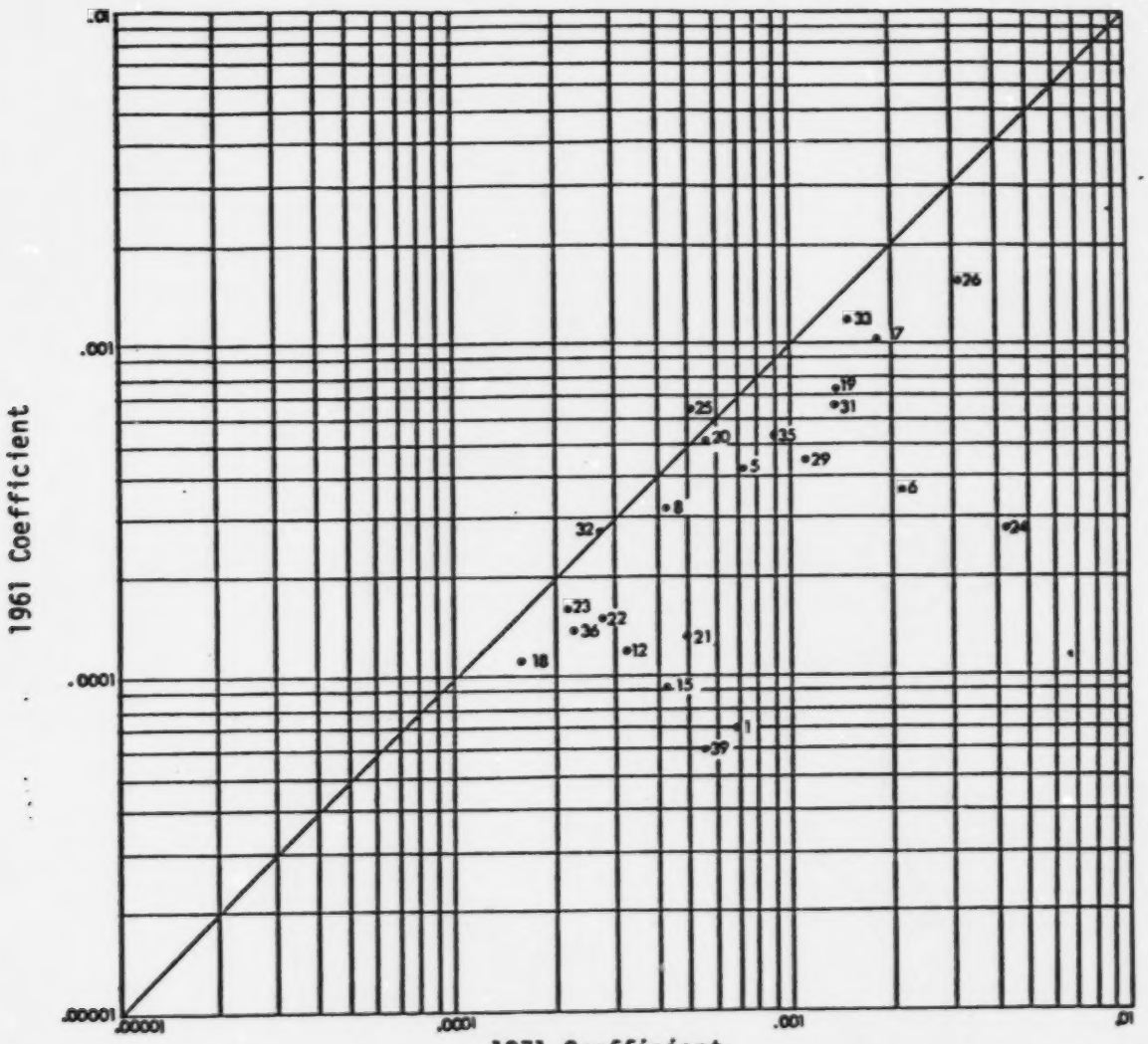
The coefficients have been illustrated by means of a series of scatter diagrams.[16] These have been designed so as to indicate those industries with a large and those with a small coefficient. The numbers next to each point indicate the industry and the name of the industry is provided at the foot of each figure. Each axis measures direct input coefficient values for a particular year. The direct coefficients for 1961 are shown as the ordinate and the 1971 as the abscissa. The 45 degree line allows the reader to judge whether coefficients were larger or smaller in one year than they were in the other year. Coefficients that were larger in 1971 than in 1961 appear below the 45 degree line, in the right hand section. Those larger in 1961 than in 1971 appear above the line in the section to the left. Since the scales are logarithmic, distance from the 45 degree line measures (relative) rates of change in coefficients. The actual estimates of the direct coefficients are included in Appendix B.

Figures 2.1 to 2.5 display the scatter of direct energy coefficients between 1961 and 1971. Figure 2.1 displays the changes in the direct coefficients for coal. These changes are distinguished in that only two industries, agriculture (1) and electric power, gas and other utilities (31), show increased direct coefficients in 1971 over 1961. All the other industries have smaller direct coal coefficients in 1971 than they had in 1961.



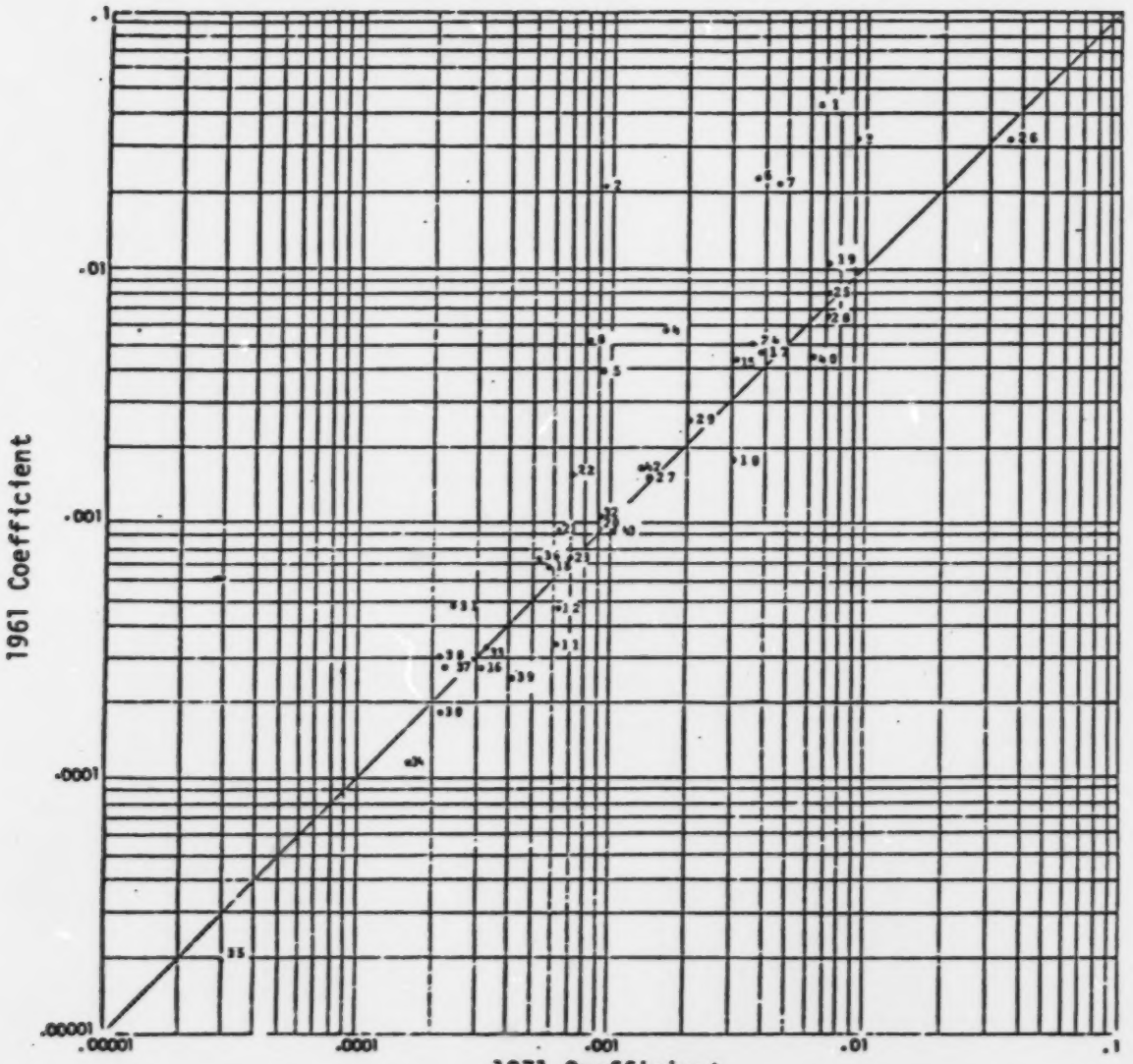

1. Agriculture
2. Forestry
3. Fishing, Hunting & Trapping
4. Metal Mines
5. Mineral Fuels
6. Non-Metal Mines & Quarries
7. Services Incidental to Mining
8. Food & Beverage Industries
9. Tobacco Products Industries
10. Rubber & Plastic Prod. Ind.
11. Leather Industries
12. Textile Industries
13. Knitting Mills
14. Clothing Industries
15. Wood
16. Furniture Fixture Industries
17. Paper & Allied Industries
18. Printing & Publishing
19. Primary Metal Industries
20. Metal Fabricating Industries
21. Machinery Industries
22. Trans. Equipment Industries
23. Electrical Products Industries
24. Non-Metal Mineral Prod. Ind.
25. Petroleum & Coal Prod. Ind.
26. Chemical & Chemical Prod. Ind.
27. Misc. Manufacturing
28. Construction Industry
29. Transportation & Storage
30. Communication
31. Electrical Power, Gas, Other Utilities
32. Wholesale Trade
33. Retail Trade
35. Owner Occupied Dwellings
36. Education & Health Services
37. Amusement Recreation Services
38. Service to Business Management
39. Accommodation, Food Services
40. Personal & Misc. Services
41. Trans. Margins
42. Operating Office, Lab & Food
43. Travel Promotion Advtg.

FIGURE 2.1: Coal Coefficients: 1961 and 1971. (Each point indicates value of the coefficient for 43-Order consuming sector.) $ Energy consumed/1961 $-output.



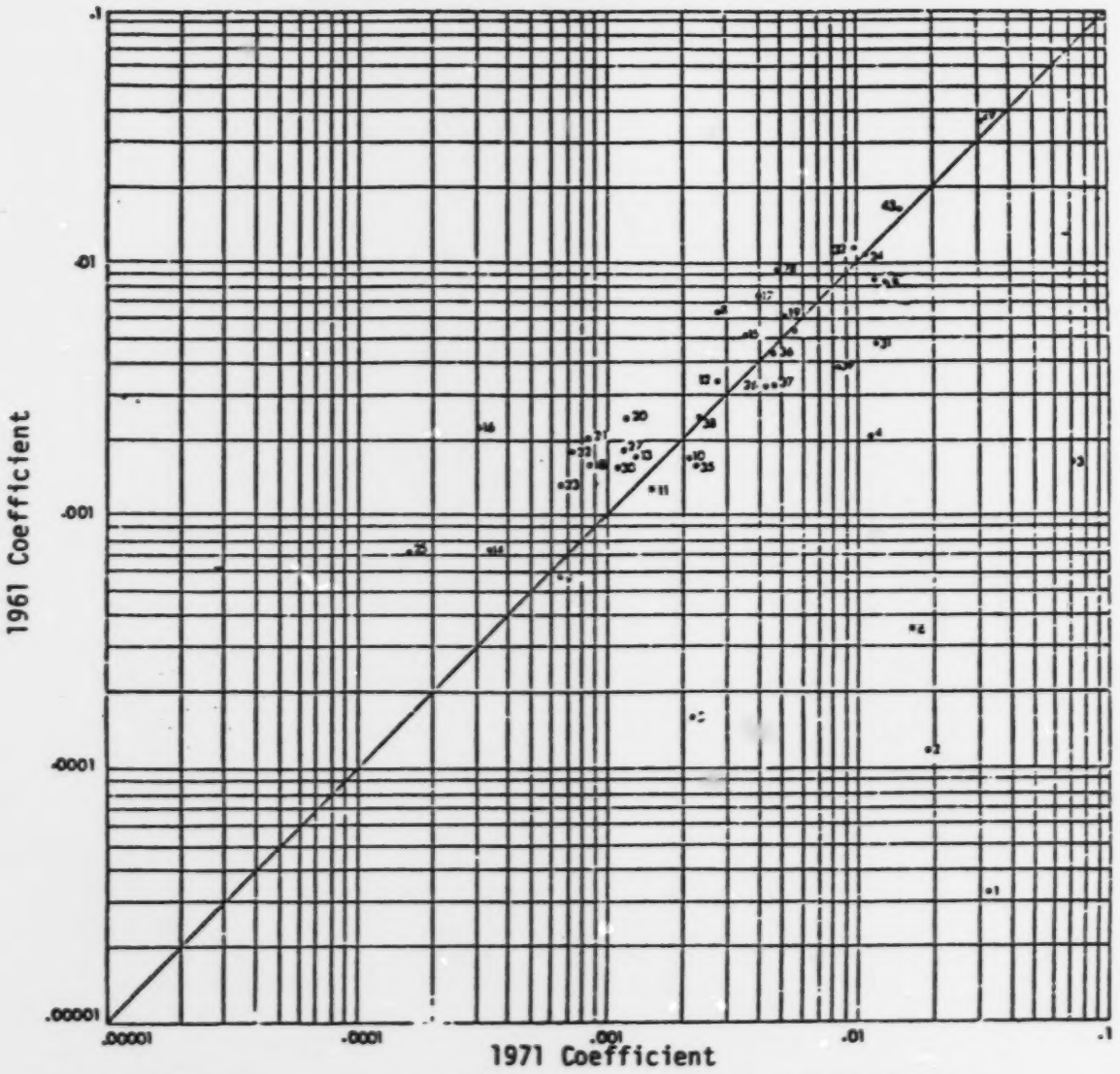

1. Agriculture
2. Forestry
3. Fishing, Hunting & Trapping
4. Metal Mines
5. Mineral Fuels
6. Non-Metal Mines & Quarries
7. Services Incidental to Mining
8. Food & Beverage Industries
9. Tobacco Products Industries
10. Rubber & Plastic Prod. Ind.
11. Leather Industries
12. Textile Industries
13. Knitting Mills
14. Clothing Industries
15. Wood
16. Furniture Fixture Industries
17. Paper & Allied Industries
18. Printing & Publishing
19. Primary Metal Industries
20. Metal Fabricating Industries
21. Machinery Industries
22. Trans. Equipment Industries
23. Electrical Products Industries
24. Non-Metal Mineral Prod. Ind.
25. Petroleum & Coal Prod. Ind.
26. Chemical & Chemical Prod. Ind.
27. Misc. Manufacturing
28. Construction Industry
29. Transportation & Storage
30. Communication
31. Electrical Power, Gas, Other Utilities
32. Wholesale Trade
33. Retail Trade
35. Owner Occupied Dwellings
36. Education & Health Services
37. Amusement Recreation Services
38. Service to Business Management
39. Accommodation, Food Services
40. Personal & Misc. Services
41. Trans. Margins
42. Operating Office, Lab & Food
43. Travel Promotion Advtg.

FIGURE 2.2: Natural Gas Coefficients: 1961 and 1971. $ Energy Consumed /1961 $ output.



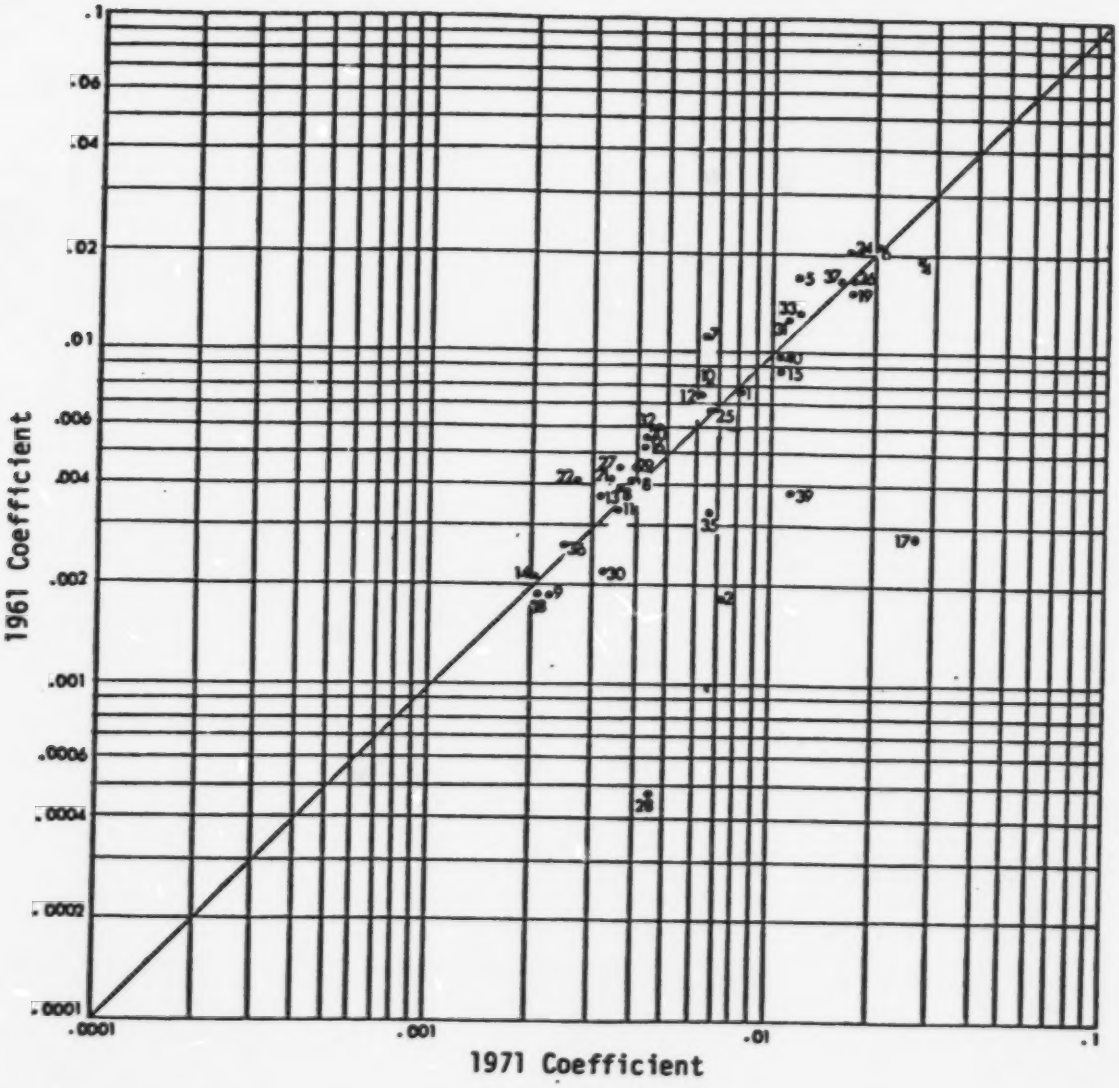

1. Agriculture
2. Forestry
3. Fishing, Hunting & Trapping
4. Metal Mines
5. Mineral Fuels
6. Non-Metal Mines & Quarries
7. Services Incidental to Mining
8. Food & Beverage Industries
9. Tobacco Products Industries
10. Rubber & Plastic Prod. Ind.
11. Leather Industries
12. Textile Industries
13. Knitting Mills
14. Clothing Industries
15. Wood
16. Furniture Fixture Industries
17. Paper & Allied Industries
18. Printing & Publishing
19. Primary Metal Industries
20. Metal Fabricating Industries
21. Machinery Industries
22. Trans. Equipment Industries
23. Electrical Products Industries
24. Non-Metal Mineral Prod. Ind.
25. Petroleum & Coal Prod. Ind.
26. Chemical & Chemical Prod. Ind.
27. Misc. Manufacturing
28. Construction Industry
29. Transportation & Storage
30. Communication
31. Electrical Power, Gas, Other Utilities
32. Wholesale Trade
33. Retail Trade
35. Owner Occupied Dwellings
36. Education & Health Services
37. Amusement Recreation Services
38. Service to Business Management
39. Accommodation, Food Services
40. Personal & Misc. Services
41. Trans. Margins
42. Operating Office, Lab & Food
43. Travel Promotion Advtg.

FIGURE 2.3: Other Petroleum & Coal Products: 1961 and 1971. $ Energy Consumed/1961 $ output.




1. Agriculture
2. Forestry
3. Fishing, Hunting & Trapping
4. Metal Mines
5. Mineral Fuels
6. Non-Metal Mines & Quarries
7. Services Incidental to Mining
8. Food & Beverage Industries
9. Tobacco Products Industries
10. Rubber & Plastic Prod. Ind.
11. Leather Industries
12. Textile Industries
13. Knitting Mills
14. Clothing Industries
15. Wood
16. Furniture Fixture Industries
17. Paper & Allied Industries
18. Printing & Publishing
19. Primary Metal Industries
20. Metal Fabricating Industries
21. Machinery Industries
22. Trans. Equipment Industries
23. Electrical Products Industries
24. Non-Metal Mineral Prod. Ind.
25. Petroleum & Coal Prod. Ind.
26. Chemical & Chemical Prod. Ind.
27. Misc. Manufacturing
28. Construction Industry
29. Transportation & Storage
30. Communication
31. Electrical Power, Gas, Other Utilities
32. Wholesale Trade
33. Retail Trade
35. Owner Occupied Dwellings
36. Education & Health Services
37. Amusement Recreation Services
38. Service to Business Management
39. Accomodation, Food Services
40. Personal & Misc. Services
41. Trans. Margins
42. Operating Office, Lab & Food
43. Travel Promotion Advtg.

FIGURE 2.4: Gasoline & Fuel Oil Coefficients: 1961 and 1971. $ Energy Consumed/ 1961 $ Output.




1. Agriculture
2. Forestry
3. Fishing, Hunting & Trapping
4. Metal Mines
5. Mineral Fuels
6. Non-Metal Mines & Quarries
7. Services Incidental to Mining
8. Food & Beverage Industries
9. Tobacco Products Industries
10. Rubber & Plastic Prod. Ind.
11. Leather Industries
12. Textile Industries
13. Knitting Mills
14. Clothing Industries
15. Wood
16. Furniture Fixture Industries
17. Paper & Allied Industries
18. Printing & Publishing
19. Primary Metal Industries
20. Metal Fabricating Industries
21. Machinery Industries
22. Trans. Equipment Industries
23. Electrical Products Industries
24. Non-Metal Mineral Prod. Ind.
25. Petroleum & Coal Prod. Ind.
26. Chemical & Chemical Prod. Ind.
27. Misc. Manufacturing
28. Construction Industry
29. Transportation & Storage
30. Communication
31. Electrical Power, Gas, Other Utilities
32. Wholesale Trade
33. Retail Trade
35. Owner Occupied Dwellings
36. Education & Health Services
37. Amusement Recreation Services
38. Service to Business Management
39. Accommodation, Food Services
40. Personal & Misc. Services
41. Trans. Margins
42. Operating Office, Lab & Food
43. Travel Promotion Advtg.

FIGURE 2.5: Electricity Coefficients: 1961 and 1971. Energy Consumed/ 1961 $ Output.

'Power, Gas and Other Utilities' was the second largest user of coal in 1971 (Table 2.7), and it appears that over the period it had been increasing its direct use of this energy commodity. The consumption of coal in the agricultural sector has been negligible in both years, and it is difficult to offer a reason for this increase in its utilization in 1971. As for the remaining industries, however, the location of the observations in the left hand side of the figure illustrates the movement away from coal and towards other energy commodities.

A commodity experiencing the exact opposite to that experienced by coal was natural gas. As Figure 2.2 shows, with the exception of the wholesale trade and the petroleum and coal producing industries, the points lie to the right of the 45 degree line, indicating that in 1971 coefficients were larger than they were in 1961. The largest increase was registered by the non-metal mineral products industries (24) which ranked fifth in size among the direct consumers of natural gas in 1971 (Table 2.2). While these points suggest that substantially more natural gas was used directly by industries over the decade, possibly at the expense of coal, it could also be that the measures used fail to consider the changing Btu conversion rate for this commodity. If a given volume of natural gas in 1961 contained less Btus in 1971 than it did in 1971, then there will be a need for increased inputs of natural gas to compensate for this decline in thermal efficiency. It appears that this may have happened, with the result that the coefficients in Figure 2.2 may overestimate the increased size of the direct natural gas coefficients.[17]

The commodity, 'Other Petroleum and Coal Products', shows a spread of points at either side of the 45 degree line. As Figure 2.3 shows, there are no industries which experienced substantial increases in direct coefficients in 1971, while agriculture (1) and forestry (2) were the two industries exhibiting the largest declines in direct use. Gasoline and fuel oil, Figure 2.4, exhibited a wider spread of changes along with some noticeable

increases in direct usage in 1971. Agriculture (1) showed substantial increases in the direct use of gasoline and fuel oil, perhaps indicating the move to increased gasoline using machines. Similar developments probably took place in the fishing, hunting and trapping industry (3) and in the forestry industry (2).

Direct electricity coefficients as shown in Figure 2.5, indicate many industries experienced little change, while a few showed marked increases in direct electricity consumption. In the latter group were the large electricity consuming industries such as paper and allied industries (17) and the accommodation and food services industry (39).

Explaining the possible reasons for the shifts in direct energy coefficients is not possible without detailed information of the movements in the direct usage of other factors of production. The preceding analysis therefore remained descriptive. However, the next section contains estimates of the total energy consumption by industry for this year. With such information it is possible to explore a little deeper into the share of direct and indirect energy consumption involved in the production of industrial outputs.

## 2.5 Total Demands for Energy Commodities

In turning to the total demand for energy commodities a number of problems are immediately faced. These are a result of the particular form of the published I-O models. The I-O model is an 'open model' in which the final demands for commodities are net of leakages. In the I-O tables the measure of industry outputs[19] include imports, but the imports are not specified by commodity for each industry. The result is that imports, which along with government production comprise the largest part of the leakages are not extractable from the industry outputs. The result is that the published I-O tables as they stand are not able to yield the total 'net' demands for energy commodities by industries. To estimate the total demands for energy commodities would involve 'closing'

the model, and calculating the total demands inclusive of imported energy commodities and government produced commodities.[20]

While such an exercise has not been published on the I-O tables, a closed I-O model has been employed using Btu energy equivalences rather than dollar values. This form of the 'energy I-O model' has been built by the Structural Analysis Division of Statistics Canada. From this source came estimates of the total prime energy consumed by industries ( L aggregation) for 1966. Details of these data are contained in Appendix C. It is sufficient to note here that some of the commodities included in 'prime' energy cannot be strictly counted under this classification. Coke was converted back into 'coal equivalences', joining coal, natural gas and electricity. The latter consisted of thermal and hydro electricity, a composition which called for the conversion of thermal electricity back into primary energy.[21] The energy commodity 'refined petroleum products', however, was not taken back and converted into crude oil.[22]

The items in the column of total energy consumed in the production of the output of industries were classified according to the L aggregation, and so involved over 180 industries. These figures were then aggregated into the M aggregation (43 industries) and the Btus consumed by each industry were divided by the value (current dollars) of the output of each of the industries. These are displayed in Table 2.12 along with the direct prime energy consumed by each industry. These sets of figures were calculated by adjusting the estimates of direct energy contained in Appendix B into 'prime' direct energy figures. The same set of industry output figures were used to obtain the prime direct energy consumed per dollar of output.

Table 2.12 shows that the petroleum and coal products industry has the largest direct energy coefficient, followed by the mineral fuel industries and the fishing, trapping and hunting industry. The second column gives the rank of the industry according to the size of the direct energy coefficient. It is interest-

TABLE 2.12

COMPARISON OF THE DIRECT AND TOTAL PRIMARY ENERGY INTENSITIES
BY INDUSTRY: CANADA 1966 (Btus/CURRENT $)

| | Industry | Direct Primary Energy Intensity '000 Btus/1$ | Rank | Total Primary Energy Intensity: '000 Btus/1$ | Rank | Ratio: Direct / Total | Rank[a] Change |
|---|---|---|---|---|---|---|---|
| 1. | Agriculture | 27.09 | 13 | 58.2 | 35 | 0.4654 | -22 |
| 2. | Forestry | 18.70 | 17 | 43.5 | 39 | 0.4299 | -22 |
| 3. | Fishing, Hunting & Trapping | 89.32 | 3 | 119.7 | 26 | 0.7460 | -23 |
| 4. | Metal Mines | 30.04 | 11 | 300.4 | 15 | 0.1000 | - 4 |
| 5. | Mineral Fuels | 93.72 | 2 | 187.7 | 22 | 0.4992 | -20 |
| 6. | Non-metal Mines & Quarries | 59.19 | 9 | 467.5 | 11 | 0.1266 | - 2 |
| 7. | Services Incidental to Mining | 58.15 | 10 | 86.9 | 31 | 0.6692 | -21 |
| 8. | Food & Beverage | 12.23 | 24 | 1084.4 | 4 | 0.0113 | +20 |
| 9. | Tobacco Products | 3.16 | 39 | 97.3 | 29 | 0.0325 | +10 |
| 10. | Rubber & Plastics Products | 21.81 | 23 | 208.5 | 20 | 0.0614 | + 3 |
| 11. | Leather | 5.81 | 32 | 193.7 | 21 | 0.0299 | +11 |
| 12. | Textiles | 17.46 | 19 | 928.3 | 7 | 0.0188 | +12 |
| 13. | Knitting Mills | 6.72 | 30 | 103.0 | 28 | 0.0650 | + 2 |
| 14. | Clothing | 1.53 | 40 | 40.6 | 40 | 0.0376 | 0 |
| 15. | Wood | 10.10 | 26 | 267.6 | 17 | 0.0377 | + 9 |
| 16. | Furniture & Fixtures | 5.09 | 35 | 184.7 | 23 | 0.0275 | +12 |
| 17. | Paper & Allied | 82.06 | 6 | 1226.7 | 3 | 0.0669 | + 3 |
| 18. | Printing & Publishing | 3.71 | 37 | 70.3 | 34 | 0.0528 | + 3 |
| 19. | Primary Metal | 88.94 | 4 | 2368.8 | 1 | 0.0375 | + 3 |
| 20. | Metal Fabricating | 8.33 | 28 | 676.0 | 9 | 0.0123 | +19 |
| 21. | Machinery | 6.25 | 31 | 209.9 | 19 | 0.0298 | +12 |
| 22. | Transport Equipment | 7.66 | 29 | 433.2 | 13 | 0.0177 | +16 |
| 23. | Electrical Products | 5.50 | 33 | 432.8 | 14 | 0.0127 | +19 |
| 24. | Non-Metal Mineral Products | 87.34 | 5 | 2028.7 | 2 | 0.0431 | + 3 |
| 25. | Petroleum & Coal Products | 114.46 | 1 | 689.8 | 8 | 0.1659 | - 7 |
| 26. | Chemical & Chemical Products | 72.74 | 7 | 995.7 | 5 | 0.0731 | + 2 |
| 27. | Miscellaneous Manufacturing | 5.15 | 34 | 458.7 | 12 | 0.0112 | +22 |
| 28. | Construction | 15.51 | 20 | 637.7 | 10 | 0.0243 | +10 |
| 29. | Transportation & Storage | 67.56 | 8 | 952.0 | 6 | 0.0710 | + 2 |
| 30. | Communication | 3.94 | 36 | 76.7 | 33 | 0.0514 | + 3 |
| 31. | Electric Power Gas & Other Utilities | 28.40 | 12 | 219.4 | 18 | 0.1294 | - 6 |
| 32. | Wholesale Trade | 19.31 | 16 | 38.9 | 41 | 0.4964 | -25 |
| 33. | Retail Trade | 24.58 | 14 | 45.5 | 38 | 0.5402 | -24 |
| 34. | Owner Occupied Dwellings | - | - | 4.2 | 43 | 0.0000 | - |
| 35. | Finance, Insurance & Real Estate | 8.84 | 27 | 49.5 | 36 | 0.1786 | - 9 |
| 36. | Education & Health Services | 14.75 | 21 | 159.9 | 25 | 0.0922 | - 4 |
| 37. | Amusement & Recreation Services | 17.93 | 18 | 84.2 | 32 | 0.2129 | -14 |
| 38. | Service to Business Management | 3.39 | 38 | 48.1 | 37 | 0.0705 | + 1 |
| 39. | Accommodation, Food Services | 13.65 | 22 | 37.7 | 42 | 0.3621 | -20 |
| 40. | Personal & Miscellaneous Services | 24.26 | 15 | 180.4 | 24 | 0.1345 | - 9 |
| 41. | Trans. margins | - | - | 87.2 | 30 | 0.0000 | - |
| 42. | Operating Office-Lab & Food | - | - | 275.3 | 16 | 0.0000 | - |
| 43. | Travel: Promotion & Advertising | 10.57 | 25 | 117.9 | 27 | 0.0897 | - 2 |

SOURCE: Statistics Canada, Structural Analysis Division.

NOTE: [a]The negative sign on the rank change is to be interpreted as a decline in the ranking; moving from 'DIRECT' to 'TOTAL' primary energy intensity.

ing to note how this ranking changes when industries are ranked according to the total energy they consume. For instance, the petroleum and coal product industry drops from first position to eighth position in the total energy consumption ranking, a drop of seven. The industry with the largest total consumption of primary energy is the primary metal industry. In looking down the column which records changes in rank[23] the largest gains were made by the miscellaneous manufacturing industries, closely followed by the metal fabricating industries, the electrical products industries and the food and beverage industries. The largest drops were experienced by the agricultural, forestry, fishing, trapping and hunting industries, and the wholesale and the retail trade. The clothing industry did not register a change in rank, but on the whole the manufacturing industries (numbers 8 to 24) were those which rose in rank, while the primary extractive and farming industries experienced the reverse. As the column of the ratios of direct to total prime energy consumed shows, the total energy consumed by the industries was significantly higher than the direct energy consumed.

The differences between the magnitudes of total primary energy and direct primary energy consumed by industries are represented by the ratios in the penultimate column in Table 2.12. Such are the differences in these magnitudes that it is worthwhile to conclude by examining the meaning of the measure of total primary energy consumption and the relationships of the larger industrial users to other factors of production.

Take for instance two industries, the food and beverage industries and the metal fabricating industries. These were among the industries registering the highest jumps in the ranking when the figures for total primary energy used were compared with the direct primary energy figures. The food and beverage industry uses relatively small amounts of prime energy in producing the food products and drinks which constitute its commodity outputs. An examination of the other inputs used by the industry[24] shows that

paper products ($270.6 million in 1971), other metal fabricated products ($166.9 million) and other chemical products ($56.8 million) ranked high in value among the inputs used by the industry. An acquaintance with the direct primary energy coefficients shows that all these commodities need considerable inputs of energy in their production. It is the 'indirect' energy needed to provide for these inputs which hoists the food and beverage industry to a high ranking in the total primary energy consumption column. The same explanation applies to the metal fabricating industry, except that here the inputs are different. They are iron and steel products, fabricated metal products, aluminum products, industrial chemicals and other chemical products.[25] These commodities also require considerable inputs of energy in their production.[26]

## 2.6 Summary

In 1971, of the energy commodities, the percentages of the total supply from domestic sources was largest for electricity, with over 99 percent produced domestically, and smallest for coal, with 28.7 percent. Turning to the direct demand for the prime energy commodities, the primary metal industries and the electric utilities were large consumers. The chemical and chemical products industries were large consumers of natural gas, while the paper and allied industries, the retail trade and the primary metal industries ranked high among the direct users of electricty. In the case of secondary energy commodities, gasoline and fuel oil had large consumers in the transportation and storage industry, the agricultural industry and the construction industry. The chemical and chemical products industry, the construction industry and the primary metal industry were large consumers of the commodity group 'Other Petroleum and Coal Products'.

Moving down to a more disaggregated industrial level, it appeared that seven manufacturing industries were the main direct

consumers of energy. They were: iron and steel mills, smelting and refining industries, pulp and paper mills, cement manufacturers, glass manufacturers, manufacturers of industrial chemicals (inorganic) and industrial chemicals (organic).

The use of data for 1966, in which direct primary energy consumptions by industry were ranked according to the amount of Btus per dollar of output, revealed a ranking which was hardly surprising in the light of the closer examination of each industry. The largest direct user of energy was the petroleum and coal products industry, followed by the mineral fuels industry, the fishing, trapping and hunting industry, the primary metal industries and the non-metal products industries. Measures of the total primary energy (direct and indirect) used by industries revealed that an industry which ranked fourth in the direct primary energy rankings jumped to first spot. This was the primary metal industry. The petroleum and coal products industry, which ranked first in the direct primary energy rankings, had dropped down to eighth in the total primary energy rankings.

This chapter has described those industries which are the most intensive users of energy commodities. In doing so it prepares the way for an understanding of the results produced by the price I-O model which is used in Chapter 4. Before moving on to that chapter, Chapter 3 is produced in order to add to the understanding of the changes that the Canadian economy underwent during the period 1966 to 1971.

## FOOTNOTES - CHAPTER 2

[1]For a description of the relationship of the I-O table aggregations and their relationship to such identities as gross domestic expenditure and GDP, consult Statistics Canada Cat. 15-501 [28], pages 14-16.

[2]Unless otherwise stated, it should be assumed that the tables under consideration are those shown in Statistics Canada Cat. 15-506E [30].

[3]As Table 2.1 shows, under the M aggregation, there are more than three energy industries and more than six energy commodities. However, the commodities listed above are those which were considered most useful in the analysis.

[4]It should be emphasized that these points concerning the aggregation of the energy commodities refer to their use in this chapter. The L commodity aggregation can and has been used in the price simulations.

[5]Wood was considered in this list, but it is thought now to play only a very minor part in providing heat.

[6]See Statistics Canada Cat. 15-506E [30], p. 31.

[7]This is equation (1.5.3), expressed earlier in a different form in Chapter 1.

[8]Most of the coal classified under government production comes from Cape Breton, Nova Scotia. It is so classified because the Cape Breton Development Corporation, which is an agent of the provincial government, has coal mining interests.

[9]It should be noted, however, that the commodity 'electricity' includes both hydro and thermal generated electricity and as such is not a prime energy commodity as defined in the previous section.

[10]See Appendix A for a discussion of the implications of this point.

[11]This introduces another difficulty with the data, namely the lumping together of the uses of energy commodities. In most industries energy commodities are used to provide heat, lighting, etc., but in some, such as in the prime metal industries, they are used for feedstock.

[12]The tables were compiled by considering aggregate percentages up to the 80 percent mark. To identify all the users of the commodities would have involved considerable extra detail in exchange for very little extra information.

[13]See Table A.10. Note that this data is for 1975 and the industries accord with the 1970 S.I.C.

[14]See Table A.11. Note that the data are for 1975.

[15]See Statistics Canada Cat. 15-506E [30], Table 85.

[16]This exposition has been used earlier by Carter [37], Hannon [47], [48] and Reardon [49] on U.S. data.

[17]This introduces points concerning the basis involved in using constant dollars against thermal units as measures of energy. See Appendix B for a discussion of some of the points involved in such a comparison.

[18]It would appear that because many plants in this sector produced and consumed their own electricity, these figures overestimate the growth of direct consumption in this sector. See Appendix A for an analysis of this point.

[19]These are the industry column totals in the Use (input) tables.

[20]In the Use (input) tables, imports of each commodity are distributed between industries according to the share of each industry's output as a percentage of total output. Such knowledge allows the imports to be calculated and extracted from the industry column. It was not undertaken, for it was considered a labourious task and one fraught with errors.

[21]One Btu of hydro was counted as one Btu in the table.

[22]The problem is the allocation of crude oil. Herendeen [39] in his study of U.S. energy costs suggests transferring the crude sold to refineries to the refineries (i.e. from the primary to the consuming secondary industry), "letting" the refining sector distribute it. He then allocates this back to crude oil. See Herendeen [39], page 144.

[23]It will be recalled that the total prime energy figures for 1966 were derived from a 'closed model'. As such, the total prime energy column can be interpreted as estimates of the amount of prime energy that would be needed from domestic sources to satsify the economy's needs.

[24]See Statistics Canada [30] Table 86, page 310.

[25]See Statistics Canada [30] Table 56, page 312.

[26]An interesting use of the total prime energy estimates is to take each industry in turn and to compare the total prime energy and the (direct) labour requirements. As Figure D.1 shows, a reduction in spending on the primary metal industries would accomplish a given energy saving with less unemployment than would a reduction in spending in the textiles industry, the clothing industry or the furniture and fixtures industry.

CHAPTER 3

# THE EFFECTS OF CHANGING TECHNOLOGY AND CHANGING FINAL DEMAND ON INTERMEDIATE INDUSTRY OUTPUTS: 1966-1971

## 3.1 Introduction

The last chapter described in some detail the changing consumption of energy commodities over the decade from 1961 to 1971. This short chapter extends the description by using the I-O tables for the last five years of this period. They are used here to describe the apparent effects of changing technology and industrial structure between 1966 and 1971 on the intermediate outputs of the industries of the economy. This is accomplished by means of a manipulation of the I-O model. It is a method which produces a useful insight into not only the changes that have been occurring in the economy over this period, but also it serves to highlight certain assumptions made in the construction of the I-O model.

The composition and movement of intermediate outputs produced by the industries provide an indicator of the effects of changing technology and organization of production. As techniques of production and organization change so do the requirements of particular inputs. In turn, the requirements of the sector of supply also change. Between any two years, however, the intermediate outputs of industries will also have changed because the final demands have changed. One method of separating out these two effects is to set the final demand at a given level and then to examine the intermediate output requirements to produce this final demand with the I-O coefficients of different years. A comparison

of the intermediate outputs required to satisfy the same final demand allows a separation to be made between the effects of changes in the structure of industry from changes in the final demand.[1]

Before proceeding to an analysis of the period 1966 and 1971 there is a need to further expose the meaning of changes in intermediate output brought about by changes in final demand. The 'technology' in the I-O model is measured by the market share matrices and the direct input coefficients. The latter expresses all the factors that go into determining how much of a commodity input is used to produce a given amount of output in a sector. This includes not only the type of technology used in the production process, but also the scale of operation and the extent of horizontal and vertical integration. Market structures can change significantly over time, a factor which is only partly captured by nominating the establishment as the producing unit. Establishments can extend forward or backwards in their operations, or they can start to contract work out to, for example, a service establishment which they had previously produced themselves. Such changes can affect considerably the output recorded as produced by an industry yet the technology employed by the industry may have changed little at all over the same period. In the case of changes in final demand this can include not only the direct use of the good or service by consumers, but also the indirect changes caused by increased demand for some good which simply uses more input in its production.

These points lead to caution in interpreting the causes of changes in intermediate output. It is a caution which has also been expressed in Chapter 2 when examining other aspects of changes as expressed by the I-O structure. The caution in this case will be extended to the interpretation placed on the causes of changes in intermediate outputs needed to produce 1971 final demand with 1971 and 1966 technologies. Before proceeding to these results, the following section presents a more formal description of the method involved in the comparison.

## 3.2 Formal Measurement of Changes in Intermediate Output Due to Changes in Technology and Changes in Final Demand

In order to illustrate these relationships, let us assume a simplified version of the I-O model described in Chapter 1, Equations 1.5.5 and 1.5.6. The I-O model we shall use here will be the square Leontief model, for the reason that it eases the exposition and is able to convey more easily the ideas contained in the operations.[2]

The relationships can be expressed as follows:

$$(I-A)^{-1} Y = X \tag{3.2.1}$$

where

X is a vector of industry outputs

Y is a vector of final demands

A is a matrix of technical coefficients.

The I-O equations for 1966 and 1971 can be represented as follows:

$$(I-A^{66})^{-1} Y^{66} = X^{66} \tag{3.2.2}$$

and

$$(I-A^{71})^{-1} Y^{71} = X^{71} \tag{3.2.3}$$

A subtraction of (3.2.2 from (3.2.3) will provide the difference in the gross output between the years:

$$X^{71} - X^{66} = (I-A^{71})^{-1} Y^{71} - (I-A^{66})^{-1} Y^{66} \tag{3.2.4}$$

Similarly, we can express the fact that the final demands for 1966 are the same as those for 1971 minus the changes that have occurred between those years. This identity is as follows:[3]

$$Y^{66} = Y^{71} - (Y^{71} - Y^{66}) \qquad (3.2.5)$$

Substituting $Y^{66}$ as defined by Equation 3.2.5 into Equation 3.2.4 we have:

$$X^{71} - X^{66} = (I-A^{71})^{-1} Y^{71} - (I-A^{66})^{-1}[Y^{71}-(Y^{71} - Y^{66})]$$

Rearranging gives:

$$X^{71} - X^{66} = [(I-A^{71})^{-1} - (I-A^{66})^{-1}] Y^{71} + (I-A^{66})^{-1}(Y^{71} - Y^{66}) \qquad (3.2.6)$$

In Equation 3.2.6 the first term on the right hand side represents the change in gross output due to the change in technology and the second term is due to the effect of the change in final demand.

## 3.3 Results

Table 3.1 presents those sets of figures for each industry at the M level of aggregation. The first column shows the difference between the outputs, measured in constant 1961 dollars, between 1966 and 1971. The second and third columns are the results of obtaining measurements of the industrial outputs required to satisfy 1971 final demands with 1966 technical coefficients. These estimates were generated by using Statistics Canada I-O model.

The second and third columns register respectively the changes in industrial outputs caused by changes in technology and

TABLE 3.1

INDUSTRY OUTPUTS REQUIRED TO SATISFY THE FINAL DEMAND OF 1971: CHANGES IN REQUIREMENTS ACCOUNTED FOR BY CHANGES IN TECHNOLOGY AND DUE TO CHANGES IN DEMAND BETWEEN 1966 AND 1971
$ million (1961 prices)

| Industry | Total Difference 1971 and 1966 | Difference Due to Using 1966 Coefficients to Produce 1971 Output | Difference Due to Change in Final Demand |
|---|---|---|---|
| Agriculture | 8.5 | -119.5 | 128.0 |
| Forestry | -4.5 | -100.2 | 95.7 |
| Fishing, Hunting & Trapping | -11.9 | -7.0 | 4.9 |
| Metal Mines | 209.9 | -87.7 | 297.6 |
| Mineral Fuels | 656.2 | 56.1 | 600.1 |
| Non-Metal Mines | 90.8 | -0.3 | 90.5 |
| Services Incidental to Mining | 31.9 | -15.2 | 47.1 |
| Food & Beverage | 1089.3 | 265.5 | 823.8 |
| Tobacco Products | 63.0 | 7.0 | 56.0 |
| Rubber and Plastics Products | 339.1 | 260.1 | 79.0 |
| Leather | -2.7 | 13.4 | -16.1 |
| Textiles | 411.9 | 153.6 | 258.3 |
| Knitting Mills | 114.5 | 83.4 | 31.1 |
| Clothing | 139.1 | 20.1 | 119.0 |
| Wood | 243.1 | -106.9 | 350.0 |
| Furniture & Fixtures | 71.3 | -3.2 | 74.5 |
| Paper & Allied | 437.0 | -73.6 | 510.6 |
| Printing & Publishing | 144.8 | -65.7 | 210.5 |
| Primary Metal | 594.9 | -2.0 | 596.9 |
| Metal Fabricating | 302.5 | -103.6 | 406.1 |
| Machinery | 11.1 | -91.2 | 102.3 |
| Transport Equipment | 2083.5 | 105.0 | 1978.5 |
| Electrical Products | 338.0 | -38.5 | 376.5 |
| Non-Metallic Mineral Products | 136.3 | -101.0 | 237.3 |
| Petroleum & Coal Products | 357.4 | -47.2 | 404.6 |
| Chemical & Chemical Products | 458.0 | 159.4 | 298.6 |
| Miscellaneous Manufacturing | 229.4 | 106.9 | 122.5 |
| Construction | 1430.1 | -152.5 | 1582.6 |
| Transport & Storage | 1532.3 | 227.3 | 1305.0 |
| Communications | 678.4 | 76.2 | 602.2 |
| Electric Power, Gas & Other Utilities | 526.6 | 51.7 | 474.9 |
| Wholesale Trade | 984.3 | -51.1 | 1035.4 |
| Retail Trade | 1047.1 | -191.0 | 1238.1 |
| Owner Occupied Dwellings | 373.4 | - | 373.4 |
| O. Finance | 1624.8 | 237.3 | 1387.5 |
| Education & Health Services | 338.4 | 2.2 | 336.2 |
| Amusement | 86.4 | -39.5 | 125.9 |
| Services to Business Management | 806.2 | 449.4 | 356.8 |
| Accommodation & Food Services | 555.2 | 21.6 | 533.6 |
| Other Personal & Miscellaneous Services | 6.9 | -23.9 | 30.8 |
| Transportation Margins | 724.3 | 65.2 | 659.1 |
| Operating, Office, Lab. & Food | 908.0 | -135.2 | 1043.2 |
| Travel & Advertising Promotion | 368.9 | -118.9 | 487.8 |
| Total | 20536.3 | 686.2 | 19850.1 |

SOURCE: Statistics Canada, Structural Analysis Division.

NOTE: The column described as 'total difference' takes the industrial outputs in 1971 and takes away the outputs in 1966. This produces the total difference in output between the years. The difference in output caused by using the 1966 direct coefficients to produce the 1971 final demands is shown in the second column, while the third column shows the difference between 1966 and 1971 caused by the change in final demand between these years. As shown in Equation 3.2.6, estimates in the second and third columns add to the total difference as shown in the first column.

the changes due to changes in final demand. A glance down the first column shows that most of the large differences in industrial outputs were recorded by the service sector. Of the ten industries with the largest changes, eight were in this sector. The two outstanding exceptions were the food and beverage industry and the transport equipment industry. The latter industry, in fact, recorded the largest change in output between 1966 and 1971.

A reorganization of these results is displayed in Table 3.2. This table ranks industries according to the size of the increase in output caused by changes in technology. Nineteen industries show increases in required output for producing the 1971 final demand with 1971 technology instead of 1966 technology. Of these industries, thirteen are in the manufacturing sector. Note that with the exception of the leather industries, all the industries increase output because of changes in final demand. According to the calculation, changes due to technology accounted for a larger proportion of change in output in six industries. These were the industries described as services to business management, rubber and plastic product industries, knitting mills, leather industries, forestry and the fishing and hunting industries. Such results suggest that these industries have experienced substantial changes in technology and market organization, but as mentioned above, discerning the exact sources of these changes is not possible from the I-O structure.

All the industries, with the exception of the leather industry, show increases in output caused by changes in final demand. Generally these changes in output caused by changes in final demand outweighed any negative change incurred by changes in technology. There are three industries which are exceptions to this observation. They are the forestry, fishing and leather industries. Note that in the latter industry the increase in output caused by changes in technology are outweighed by the negative change caused by changes in final demand.

These results help to add to the description of the change

TABLE 3.2

COMPARISONS OF CHANGES IN THE OUTPUT OF INDUSTRIES BROUGHT ABOUT BY CHANGES IN TECHNOLOGY AND IN CHANGES IN FINAL DEMAND: 1971 FINAL DEMAND
$ million (1961 prices)

| | | Change in Requirements | |
|---|---|---|---|
| Industry | | Changes Due to Technology | Changes Due to Changing Final Demand |
| Gaining | | | |
| 38 | Services to Business Management | 449.4 | 356.8 |
| 8 | Food & Beverage Industries | 265.5 | 823.8 |
| 10 | Rubber & Plastic Products | 260.1 | 79.0 |
| 35 | Other Finance, Ins. & Real Estate | 237.4 | 1387.5 |
| 29 | Transportation & Storage | 227.3 | 1305.0 |
| 26 | Chemical & Chemical Products | 159.4 | 298.6 |
| 12 | Textile Industries | 153.7 | 258.3 |
| 27 | Miscellaneous Manufacturing | 106.9 | 122.5 |
| 22 | Transportation Equipment | 105.0 | 1978.5 |
| 13 | Knitting Mills | 83.5 | 31.1 |
| 30 | Communication | 76.3 | 602.2 |
| 41 | Transportation Margins | 65.3 | 659.1 |
| 5 | Mineral Fuels | 56.2 | 600.1 |
| 31 | Electric Power, Gas & Other Utilities | 51.7 | 474.9 |
| 39 | Accommodation & Food Services | 21.6 | 533.6 |
| 14 | Clothing Industries | 20.2 | 119.0 |
| 11 | Leather Industries | 13.5 | -16.1 |
| 9 | Tobacco Products Industries | 7.0 | 56.0 |
| 36 | Education & Health Services | 2.2 | 336.2 |
| Declining | | | |
| 33 | Retail Trade | -191.1 | 1238.1 |
| 28 | Construction Industry | -152.6 | 1582.6 |
| 42 | Operating, Office, Lab & Food | -135.3 | 1043.2 |
| 1 | Agriculture | -119.6 | 128.0 |
| 43 | Travel & Advertising Promotion | -119.0 | 487.8 |
| 15 | Wood Industries | -107.0 | 350.0 |
| 20 | Metal Fabricating Industries | -103.7 | 406.1 |
| 24 | Non-Metallic Mineral Products | -101.0 | 237.3 |
| 2 | Forestry | -100.3 | 95.7 |
| 21 | Machinery Industries | -91.3 | 102.3 |
| 4 | Metal Mines | -87.7 | 297.6 |
| 17 | Paper & Allied Industries | -73.6 | 510.6 |
| 18 | Printing & Publishing | -65.7 | 210.5 |
| 32 | Wholesale Trade | -51.1 | 1035.4 |
| 25 | Petroleum & Coal Products | -47.2 | 404.6 |
| 37 | Amusements & Recreation Services | -39.5 | 125.9 |
| 23 | Electrical Products Industries | -38.6 | 376.5 |
| 40 | Other Personal & Misc. Services | -23.9 | 30.8 |
| 7 | Services Incidental to Mining | -15.3 | 47.1 |
| 3 | Fishing, Hunting & Trapping | -7.1 | 4.9 |
| 16 | Furniture & Fixture Industries | -3.2 | 74.5 |
| 19 | Primary Metal Industries | -2.1 | 596.9 |
| 6 | Non-Metal Mines & Quarries | -0.3 | 90.5 |

SOURCE: Statistics Canada, Structural Analysis Division. Table 3.1.

NOTES: Industries are ranked according to the size of the change in output due to technological change. An industry that is listed as 'gaining' has a positive value for the difference between the 1971 final demand produced with 1966 technical coefficients. For industries listed as 'declining' the reverse is the case. Alongside these estimates are changes due to changing final demand.

in the period 1966 to 1971.[4] They suggest that, while technical and market changes combined to affect the requirements of intermediate outputs, specification of the exact cause of the change was not possible. This was because the I-O model includes (among other changes) changes in both technology and market structure over time.

## FOOTNOTES - CHAPTER 3

[1]The methodology used in this chapter draws heavily upon the work developed by Carter [37], Reardon [49], and Strout [50].

[2]This exposition is drawn from the work of Strout [50] and Reardon [49].

[3]The final demand for 1971 could also have been expressed as: $Y^{71} = Y^{66} + (Y^{71} - Y^{66})$. See Martin [42] for a discussion of the implications of selecting one base year over another.

[4]See also the work of Hannon [47] and [48] and Reardon [40] who have used versions of an energy I-O model to examine the changing energy requirements resulting from changing economic structures.

# CHAPTER 4

# THE IMPACTS OF RISING ENERGY COSTS ON CANADIAN INDUSTRIES: 1971

## 4.1 Introduction

A sharp rise in the price of energy can be seen to result in direct and indirect cost increases for industries. They in turn are likely to pass on some of these increases by raising the prices of their goods and services. The prices of final goods and services will increase, increases which will elicit responses from consumers who will adjust their demand, resulting in changes in income and employment throughout the economy. The price I-O model offers a means of measuring the direct impacts resulting from such sharp increases in prices.

This chapter produces the results of applying this model to the 1971 I-O tables, the latest tables available at the time of writing. Before proceeding to these results it is necessary to briefly review the role of the price I-O model in order to establish the form in which it has been used in this study. In this way it is hoped to provide a clearer interpretation of the measurements resulting from the model.

The price I-O model used in this study is a cost push price model. Firms are seen to face demand conditions such that they are able to push up their prices without losing their markets. They are faced with processes of production in which all inputs are employed in rigidly fixed proportions. The response of the firm to a change in its costs is immediate. It raises its prices immediately, for in the economy perceived by the model there are no time

lags in response to cost changes. The effects of the cost price changes stop at the final demand sector, for the model does not specify the effects on income and output of changes in final demand in response to changing prices. The model measures the impact of changes in prime factor inputs on the prices of commodities and on the prices of the outputs of industries. It does not measure the effects on income and employment.[1]

An acquaintance with the various markets of the economy suggests that not all of them impose behaviour on their constituent firms in the manner implied by the price I-O model. Markets vary in the degree of their competitiveness, and they vary in the speed to which prices adjust in response to changes in costs. Sharp increases in one input relative to another input are likely to cause firms to substitute the cheaper for the more expensive input.

One result of these qualifications to the assumptions of the I-O price model is that the measures of the price responses to changes in costs produced by the model are likely to overestimate the price changes that actually occur. The actual prices can play a key part here, for by registering these prices and comparing them with the prices predicted by the price I-O model, a means can be established of 'testing' the behavioural assumptions of the model. Such an exercise involves observing and measuring the changes in all the prime input prices, introducing these into the model and observing the resulting predictions against the actual prices.

To enjoy the confidence to pronounce judgement on the appropriateness of the behavioural assumptions of the model requires a careful selection of input prices. If such an exercise is not carefully undertaken then the interpretations can be far from unambiguous. Such care is time consuming. More importantly, however, the objective of the study is to comprehend the consequences of changes in rising energy costs on Canadian industry. More specifically, the objective of the study is not to duplicate the actual prices occuring over this period and then to test the

ability of the price I-O model to predict changes in prices. Rather, the objective of the study is to comprehend the likely effects on the costs incurred by industries and on the prices they charge for their goods and services resulting from increases in energy costs. Such an objective is best served by considering a set of price increases whose range comprehends past increases and possible increases in energy prices in the future. In employing the I-O price model to measure the impacts of these price changes use is made of a model which can utilize a comprehensive set of information about the economy. At the same time, the simplifying behavioural assumptions of the model are recognized to the extent that caution is exercised when interpreting the results.

This approach involves the selection of a set of energy prices which will satisfy the objective of assessing the likely impacts on industry of rising energy costs. This task introduces the following section, 4.2.1, of the chapter. After this has been completed, the section concludes with a description of the results of the energy price changes on the prices of commodities and industries outputs (Section 4.2.2).[2] Section 4.3 continues the analysis further by examining the likely effects of changes in demand in response to changes in the prices of final commodities. Section 4.4 takes the major results of sections 4.2 and 4.3 and compares them with the results of similar studies conducted within the provinces and in the U.S.

## 4.2 Energy Price Simulations

### 4.2.1 Specifications of the Price Simulations

The price I-O model is used to measure the impact of substantial changes in energy prices. The approach adopted has been to isolate these changes in energy prices from the changes in other prime input costs. It is an approach which allows the measurement solely of the impact of changes in energy costs on the prices of

commodities and on the output of industries. Interpretation of the results, however, requires a careful consideration of the methodology involved in using energy prices as 'exogenous' variables. It also involves an appreciation of the form in which the data have been compiled, for the form of the data can, in certain instances, affect considerably the interpretation of the results.

The exercise begins by specifying the prices of prime energy commodities as exogenous to the model. The prices of those commodities are specified, introduced into the model and the consequences of these new price levels are measured by the impacts they have on the prices of other commodities and on the prices of the output of industries. The assumptions implied in such a specification can be seen by assuming that the domestic and import prices of crude oil have been increased, and that the prices of all other commodities (domestic and imported) have been held constant. The justification for this specification is that the international price of oil is set by OPEC, over which Canada has little or no control. The price of imported oil is 'given'. Domestic prices are regulated by federal and provincial institutions, and the levels of these are linked to the international price of oil. Oil prices, in short, are subject to regulation by international market organizations and by regulating authorities.

While a strong argument can be used to substantiate the choice of crude mineral oil prices as exogenous variables in the model, those supporting a similar role for the other prime energy commodities are less secure. Of the prime energy commodities used in the model, namely crude mineral oil, natural gas, coal, electicity and uranium, only the price of the first and the last commodity can be confidently treated as exogenous variables. Natural gas, in many instances, is a commodity often jointly produced with crude oil. Although there have been periods when the prices of the two diverged considerably, since 1975 the domestic prices of both crude oil and natural gas have been closely linked. This is a relationship which suggests price interdependence between

the two commodities. In the case of electricity, the prices of all thermal generated electricity are affected by the prices of other primary energy commodities, including uranium and natural gas as well as oil and coal. Electricity prices, however, are regulated by provincial authoritites and have not been subjected as directly to the open forces of the market as have the prices of coal.

There also remains the question of the interdependence of energy commodity prices and other commodity and prime input prices. If, say, import prices of crude oil rise, then so are likely the prices of other imported commodities. Higher oil prices can also be seen to be linked to higher wage claims by the pressure they place, for instance, on households to compensate for higher transport and heating costs. By isolating increases in the prices of energy from rises in the prices of other commodities and prime inputs, the model serves to ignore these relationships. Rather than 'explaining' the process of inflation, it is being used to measure the impact of the hypothetical events of isolated rises in energy prices.

Table 4.1 presents details of the ten price simulations which have been conducted on the 1971 Statistics Canada I-O tables. In the choice of these simulations an attempt has been made to consider some of the points just raised. A distinction is made between primary energy and secondary energy commodities. The former are involved, in varying combinations, in the first eight simulations. The last two, numbers 9 and 10, involve the secondary energy commodities of aviation gasoline, motor gasoline, fuel oil and other petroleum and coal products. Electricity, despite the points made earlier, has been placed among the group of primary energy commodities. The first simulation involves the doubling of the domestic and import prices of crude mineral oil. The second simulation examines the situation where the import prices double, but the domestic prices only increase by 50 percent. Simulation 4 involves the doubling of domestic and import prices of natural gas, while Simulation 7 recognizes the interrelated nature of these two

TABLE 4.1

PRICE CHANGES OF ENERGY COMMODITIES SIMULATED ON STATISTICS CANADA'S PRICE INPUT-OUTPUT MODEL: 1971

| Simulation Number | Energy Commodities | Percentage Increase | All Other Commodities |
|---|---|---|---|
| 1 | Price of Domestic Crude Mineral Oil | 100 | All prices held |
| | Price of Imported Crude Mineral Oil | 100 | constant |
| 2 | Price of Domestic Crude Mineral Oil | 50 | All prices held |
| | Price of Imported Crude Mineral Oil | 100 | constant |
| 3 | Price of Domestic Coal (all types) | 100 | All prices held |
| | Price of Imported Coal (all types) | 100 | constant |
| 4 | Price of Domestic Natural Gas | 100 | All prices held |
| | Price of Imported Natural Gas | 100 | constant |
| 5 | Price of Domestic Electric Power | 100 | All prices held |
| | Price of Imported Electric Power | 100 | constant |
| 6 | Price of Domestic Radioactive Ores & Concentrates | 100 | All prices held |
| | Price of Imported Radioactive Ores & Concentrates | 100 | constant |
| 7 | Prices of Domestic and Imported Crude Mineral Oil | 100 | All prices held |
| | Prices of Domestic and Imported Natural Gas | 100 | constant |
| 8 | Prices of Domestic and Imported Crude Mineral Oil | 100 | All prices held |
| | Prices of Domestic and Imported Natural Gas | 100 | constant |
| | Prices of Domestic and Imported Electric Power | 100 | |
| | Prices of Domestic and Imported Coal (all types) | 100 | |
| 9 | Domestic and Import prices of Aviation Gasoline | 100 | All prices held |
| | Domestic and Import prices of Motor Gasoline | 100 | constant |
| | Domestic and Import prices of Fuel Oil | 100 | |
| 10 | Domestic and Import prices of Gasoline | 100 | All prices held |
| | Domestic and Import prices of Fuel Oil | 100 | constant |
| | Domestic and Import prices of Other Petroleum and Coal Products | 100 | |

energy commodities by considering the effects of doubling both the domestic and import prices of crude mineral oil and natural gas. In the face of possible objections, coal prices are treated as exogeneous variables, and are examined in Simulation 3, while Simulation 5 examines the impact of doubling electricty prices. In view of the expected growth of nuclear generated electricty plants in the future, the effects of doubling the price of uranium ('radio active ores and concentrates') are examined in Simulation 6. Finally, Simulation 8 examines the impacts on the economy of doubling the domestic and import prices of crude mineral oil, natural gas, electricity and coal.

If these chosen price changes are compared with past changes in energy prices, as shown in Table 1.1, it will be seen that with the possible[3] exception of imported oil prices, they are on the high side. The future price movements of energy prices are closely linked with the future world price of oil. The movement of domestic oil and gas prices towards the world price of oil is a stated objective of Canadian energy policy. As a result, the major difference between the forecasts will be their prediction of the level of international oil prices and the speed with which domestic oil and gas prices will reach them. A number of these forecasts suggest that the world price of oil will keep pace with world prices; others suggest, for example, an increase in prices in the mid-1985s[4] of a similar magnitude to the rise in the mid-1970s.

A means of introducing the results of the simulations is to outline the effects of doubling the import and domestic prices of crude mineral oil. These prices are doubled, while the prices of all other commodities and prime inputs are held constant. The higher priced crude mineral oil is transported by pipeline to the petroleum refineries and the 'other petroleum and coal products industries'.[5] These industries transform the crude mineral oil, with the aid of other commodity and prime imputs into secondary energy commodities, such as motor gasoline, fuel oil, lubricating

oils and greases, etc.[6] The increased prices of these secondary commodities is determined by the refining industries cost functions. These higher priced secondary energy commodities are then transported to the industrial users and to the retail outlets. The prices of the output of the industrial users increase in a similar manner, while the retail outlets add their margins to form the prices which they ask from the consumer. The increased price of the oil works its way through the economy, sending up the prices of commodities and industrial output prices. In consequence, the costs of providing the transportation of the crude oil increases, in part because of the increased price of motor gasoline. Similarly the costs of producing the commodities which are used as inputs in the oil refining industries increase. The result is an addition of indirect cost increases which accompany the 'first round' direct cost increases.

These cost and price changes will take time to work through the economy. Some prices will rise faster than others, for example gasoline prices are likely to rise faster than rental accommodation for the effects of higher heating costs cannot be immediatley passed along to tenants owing to the length of the lease agreements. The I-O price model, however, measures the direct and indirect price impacts as if they occur simultaneously. The impacts are measured as if there were no time lags.

Finally, before moving on to consider the results, a number of points should be raised concerning the energy commodities as they appear in the I-O tables. It will be recalled that in Chapter 2 reference was made to the fact that the measures in the I-O tables record only the energy commodities purchased. They do not record energy which is produced within an establishment and then used within the establishment. Furthermore, the I-O tables do not distinguish the purposes to which the energy commodities are used. As a result, the exact amount of the energy commodity which is used as 'energy' as distinct from feedstocks, is not detectable directly from the tables.

Electricity appears to be the most important energy commodity generated and then used by establishments. Details of the sources of electrical generating capacity suggest that industrial establishments accounted for 10 percent of Canada's electrical generating capacity in 1975.[7] An examination of the importance of this source of energy by industry revealed[8] that only in the primary metal industries[9] is own generated electricity a large source of energy. It would appear that the direct energy coefficients derived from the I-O tables will reveal lower energy intensities per output in this industry than is in fact the case.

In the iron and steel industry a considerable amount of coal is used not as energy, but as a feedstock in the process of producing iron and steel. Nevertheless, coal inputs are recorded[10] in the I-O tables, an inclusion which suggests that in this industry the direct energy coefficient will be overstated.

### 4.2.2 Price Simulation Results: 1971

This section contains the summarized results of the ten simulations conducted on the 1971 I-O tables. These simulations are described in Table 4.1.

The price I-O model has been described in Chapter 1.5.[11] It will be recalled that in the model form used in the simulations, profit margins are assumed to be maintained in current dollars. The year in which the model is applied is 1971, and consequently the tables for that year provide the measures of the input and market share coefficients.

The model presents four major sets of results.[12] The commodity space results consist of four vectors. These include domestic commodity prices $Pqd$, commodity prices $Pq$, import prices $Pm$ and the import proportions $\mu$. The industry space results consist of the industry selling price indexes $Pg$ while the final demand space results present final demand price indexes, which are weighted sums of commodity prices, the weights being the

final demand coefficients by category. The fourth set of results comprise the consumer price indices.

In this section three sets of results are presented. For each simulation, the effects of the changes in energy commodity prices[13] on industry prices are recorded. The results are provided in the more numerous L aggregation, a fact which necessitated selecting the more important impacts. This was achieved by selecting the larger price changes and then presenting the commodity and industry price changes in decreasing order of magnitude. The method used has been to draw bar diagrams, of which there are twenty. The number of the figure denotes the simulation number, and the letter 'A' denotes the commodity price changes and the letter 'B' industry price changes. The effects of the price changes on the CPI and its constituent items are described in Table 4.2, while the effects on final demand prices are described separately in Section 4.3.

In Simulation 1 crude mineral oil prices were raised by 100 percent. Figure 4.1.A records the commodity price changes resulting from this increase. The ends of the lines denote the extent of the price changes and the numerical values are also shown on the figures. All increases greater than 5.06 percent were recorded, which involved the top 35 commodities. Not surprisingly, the secondary oil commodities, such as motor gasoline (67 percent), aviation gasoline (66 percent) and fuel oil (60 percent) headed the list. Chemical commodities increased in price from 5 to 6 percent. Industry prices greater than 2.5 percent were recorded, involving 34 industries. The effects, shown in Figure 4.1.B, show that industry price increases were headed by the oil refining industries. The industrial chemical manufacturers (5.9 percent) and the air transport industry (4.3 percent) were also high. The CPI increased by almost 2 percent (Table 4.2), with transportation registering the largest increase (4.3 percent).

Simulation 2 considered the effect of raising crude mineral import prices by 100 percent and holding domestic crude oil price

TABLE 4.2

CHANGES IN THE CONSUMER PRICE INDEX AS A RESULT OF THE PRICE SIMULATIONS

| Consumer Price Index/ Simulation No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C.P.I. | 1.019 | 1.014 | 1.003 | 1.002 | 1.025 | 1.000 | 1.022 | 1.048 | 1.027 | 1.004 |
| C.P.I. | | | | | | | | | | |
| Food | 1.019 | 1.014 | 1.002 | 1.001 | 1.016 | 1.000 | 1.020 | 1.037 | 1.024 | 1.006 |
| Non-Food | 1.020 | 1.014 | 1.004 | 1.003 | 1.028 | 1.000 | 1.023 | 1.052 | 1.028 | 1.004 |
| Housing | 1.019 | 1.014 | 1.007 | 1.006 | 1.054 | 1.000 | 1.025 | 1.079 | 1.030 | 1.002 |
| Clothing | 1.008 | 1.006 | 1.002 | 1.001 | 1.012 | 1.000 | 1.009 | 1.021 | 1.009 | 1.003 |
| Transportation | 1.043 | 1.032 | 1.001 | 1.001 | 1.008 | 1.000 | 1.044 | 1.053 | 1.058 | 1.010 |
| Health | 1.009 | 1.007 | 1.002 | 1.001 | 1.012 | 1.000 | 1.011 | 1.024 | 1.010 | 1.004 |
| Recreation, Education, and Reading | 1.008 | 1.006 | 1.002 | 1.001 | 1.012 | 1.000 | 1.009 | 1.022 | 1.010 | 1.002 |
| Tobacco and Alcohol | 1.006 | 1.005 | 1.001 | 1.000 | 1.008 | 1.000 | 1.007 | 1.016 | 1.008 | 1.002 |

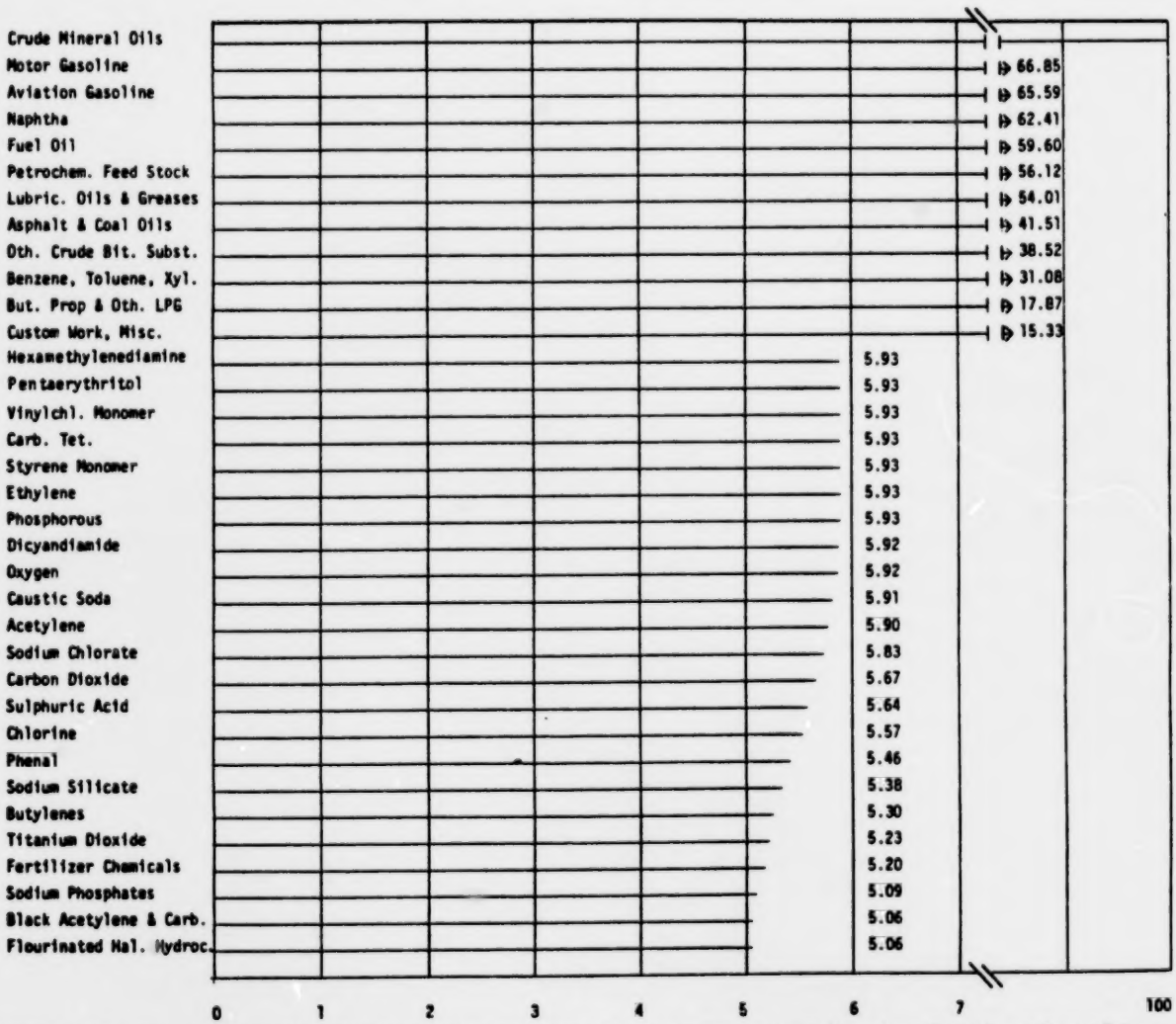



FIGURE 4.1.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of the Domestic and Import Prices of Crude Oil: Simulation 1 (1971)

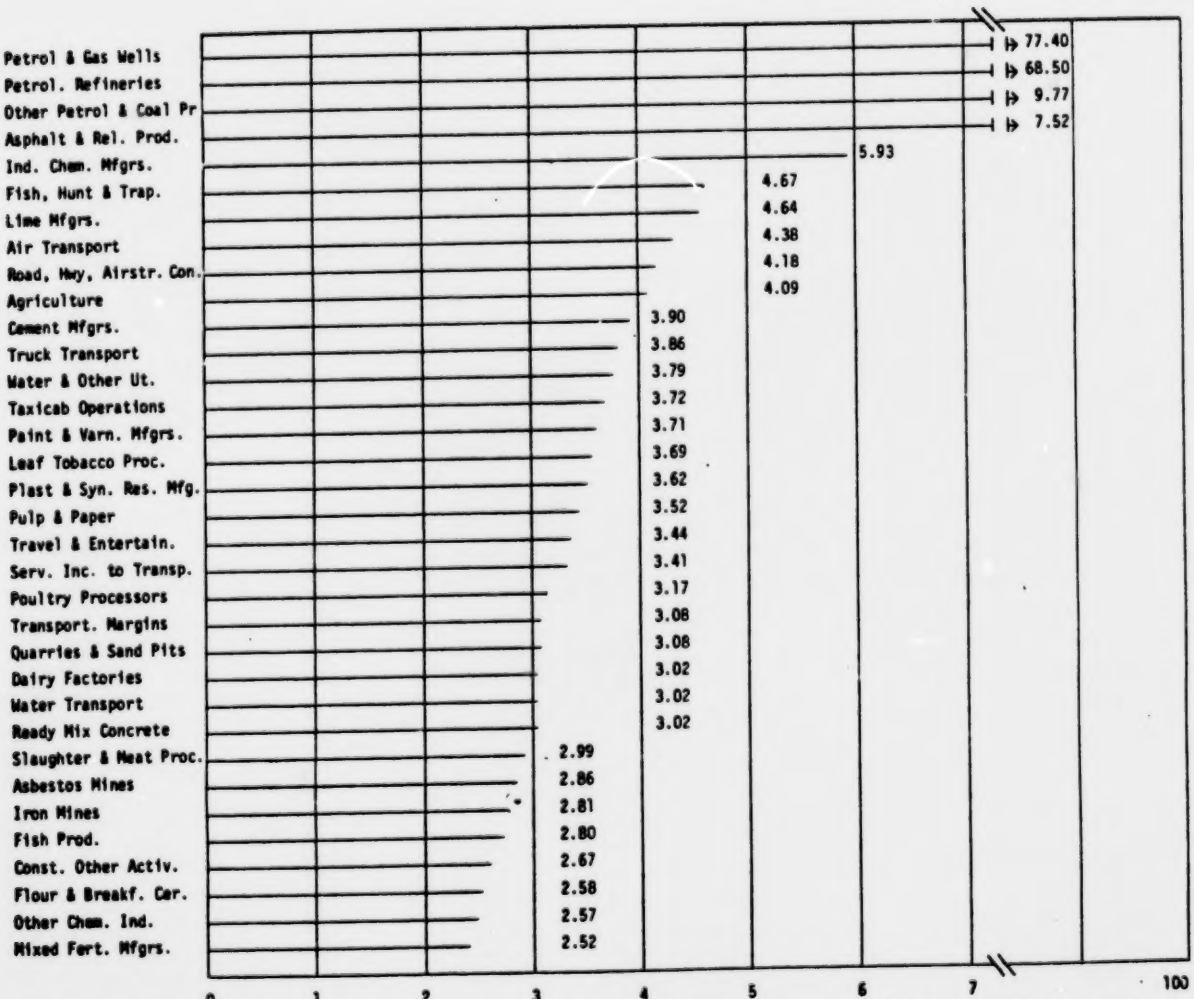



FIGURE 4.1.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of the Domestic and Import Prices of Crude Oil: Simulation 1 (1971)

increases to 50 percent. The effects on commodity and industry prices, as shown in Figures 4.2.A and 4.2.B, are lower than those caused by Simulation 1. This is due to the high import coefficient.[14]

The domestic and import prices of coal are doubled in Simulation 3. Note that in Figure 4.3.A the commodity electric power increased by almost 12 percent, galvanized steel, sheet and strip by 7.2 percent, tinplate also by 7.2 percent and carbon and steel sheets not coated by 7.0 percent. The commodities of the steel industry accounted for the top fifteen of the top sixteen commodity rankings, a fact which underlines the predominant use of coal in the iron and steel and electricity industries.[15] Indeed, this is borne out in Figure 4.3.B, in which the prices of the electric power industry increased by 12 percent and the iron and steel industry by 7.4 percent. Note also the increase in the price of the output of the lime industry. This increased by 5.8 percent, a fact which partly[16] accounts for the rise in housing costs (0.7 percent, Table 4.2). The CPI index, however, showed only a modest increase of 0.3 percent.

The doubling of natural gas prices (Simulation 4, Figures 4.4.A and 4.4.B) resulted in low commodity and industry price increases. Of the commodities, pipeline transport was high with an increase of 5 percent, while cement and lime registered 2 and 1.8 percentages respectively. Chemical commodities were found throughout the list. The petroleum and gas well industry increased by 16.6 percent, pipeline transport by 5.7 and lime manufacturers by 2.1 percent. The latter indicating, along with the increased costs of natural gas to the household, the impact of natural gas prices on housing in the CPI. These increased by 0.6 percent (Table 4.2) while the CPI rose by only 0.2 percent.

The most noticeable effect of doubling the price of electric power (Simulation 5, Figures 4.5.A and 4.5.B) resulted in increases in the prices of industrial chemical commodities. All the top fourteen industrial chemical commodities had increases of

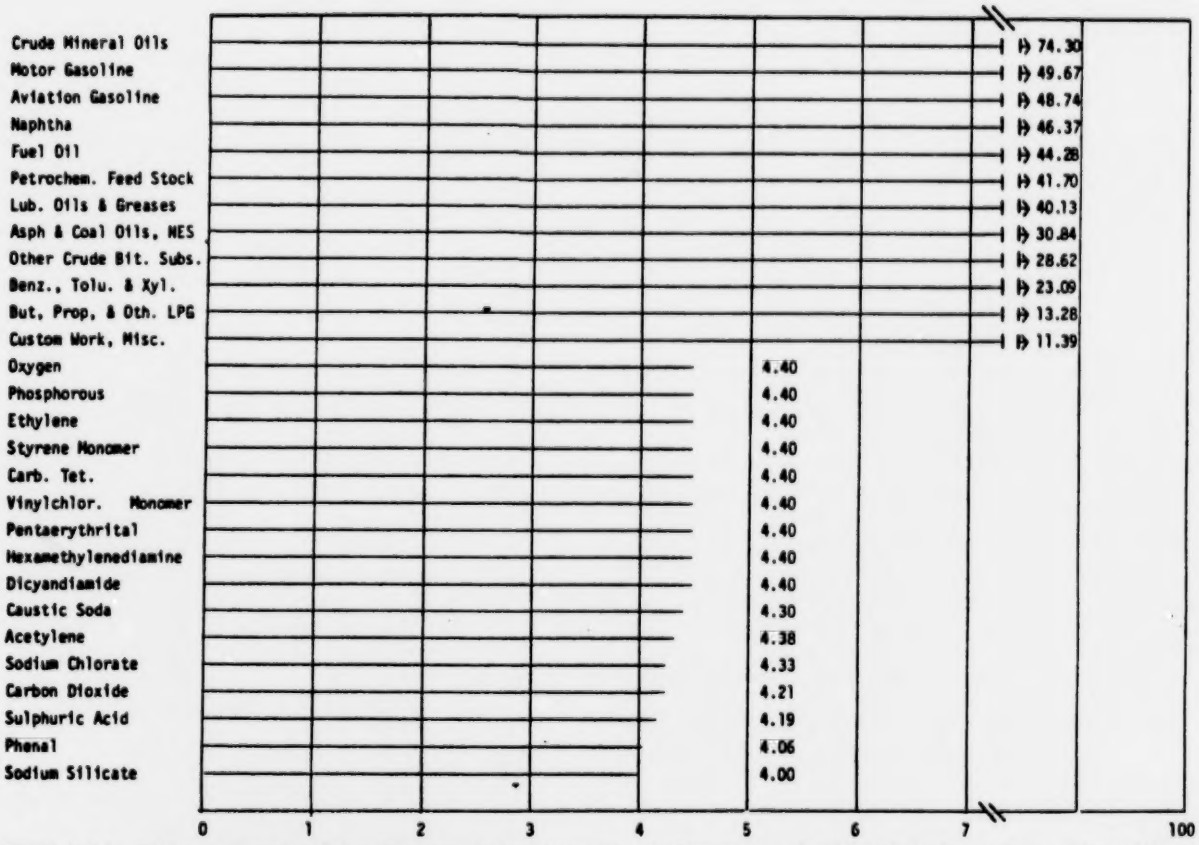



FIGURE 4.2.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of the Import Price of Crude Oil and an Increase of Fifty Percent in the Domestic Price of the Same Commodity: Simulation 2 (1971)

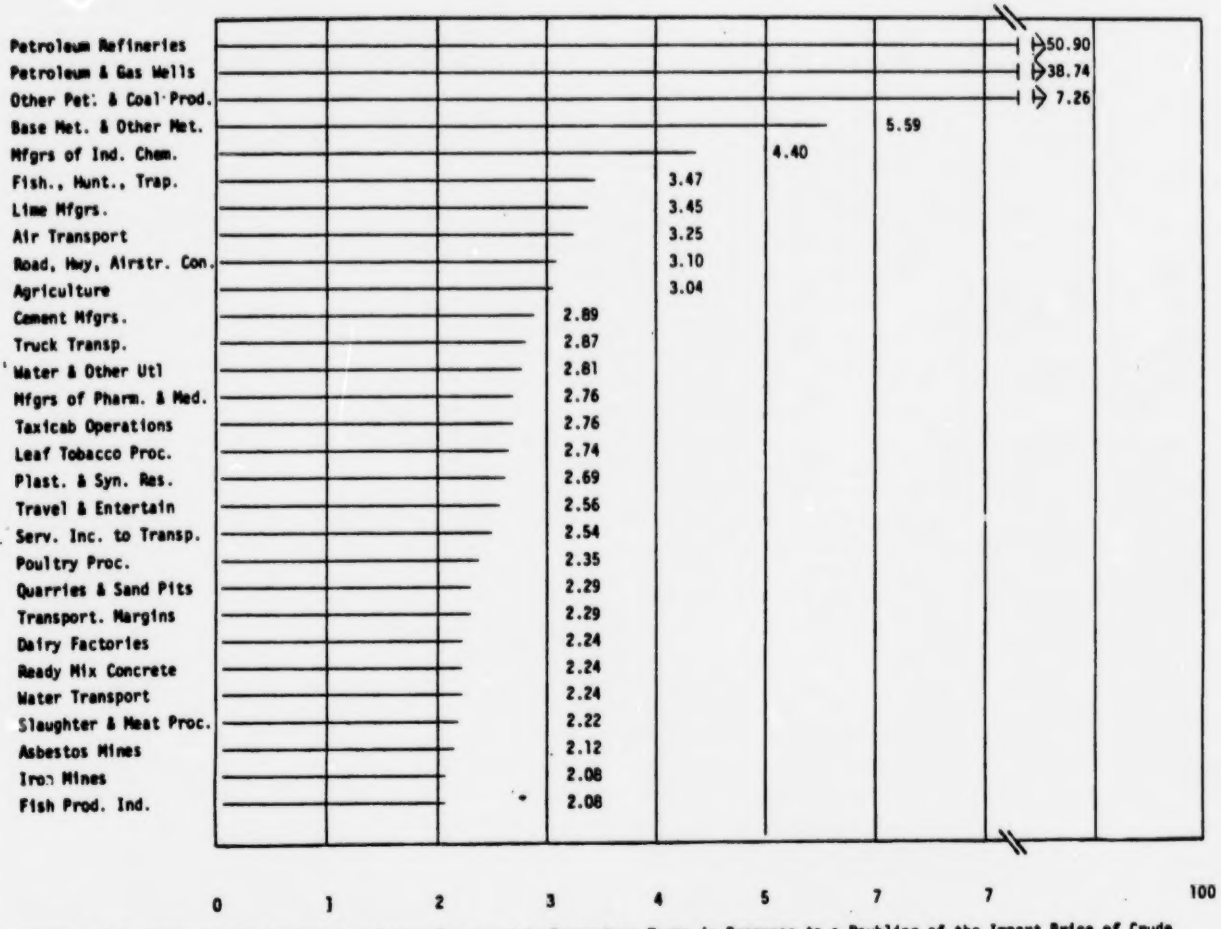



FIGURE 4.2.8: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of the Import Price of Crude and an Increase of Fifty Percent in the Domestic Price of the Same Product: Simulation 2 (1971)

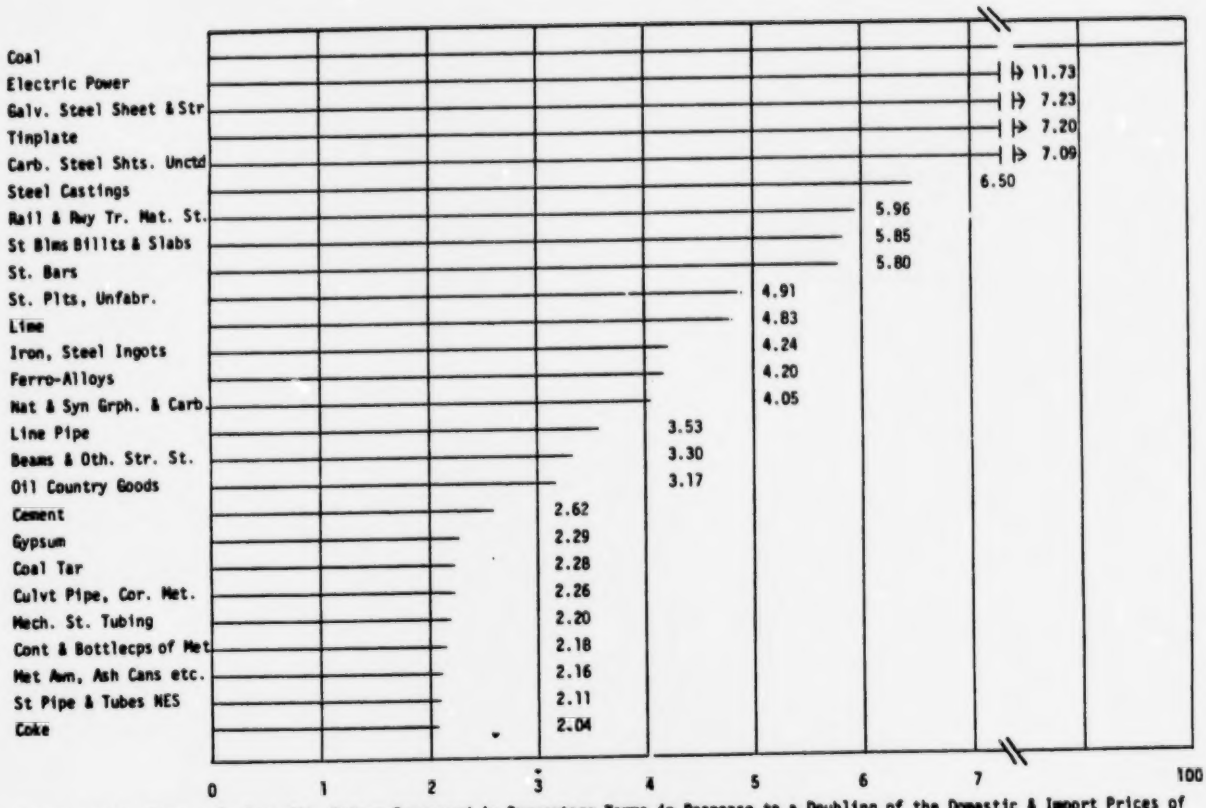



FIGURE 4.3.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of the Domestic & Import Prices of Coal: Simulation 3 (1971)

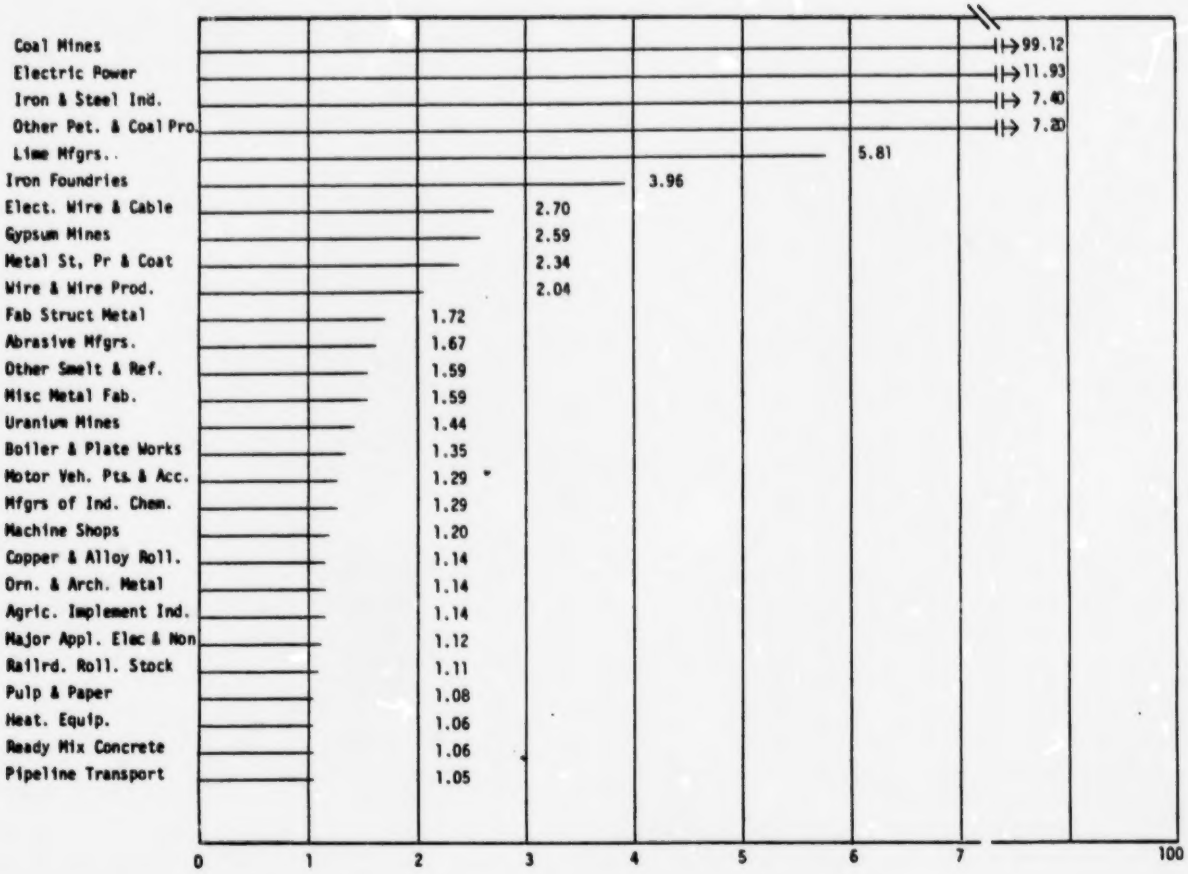



FIGURE 4.3.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of Both the Domestic & Import Prices of Coal: Simulation 3 (1971)

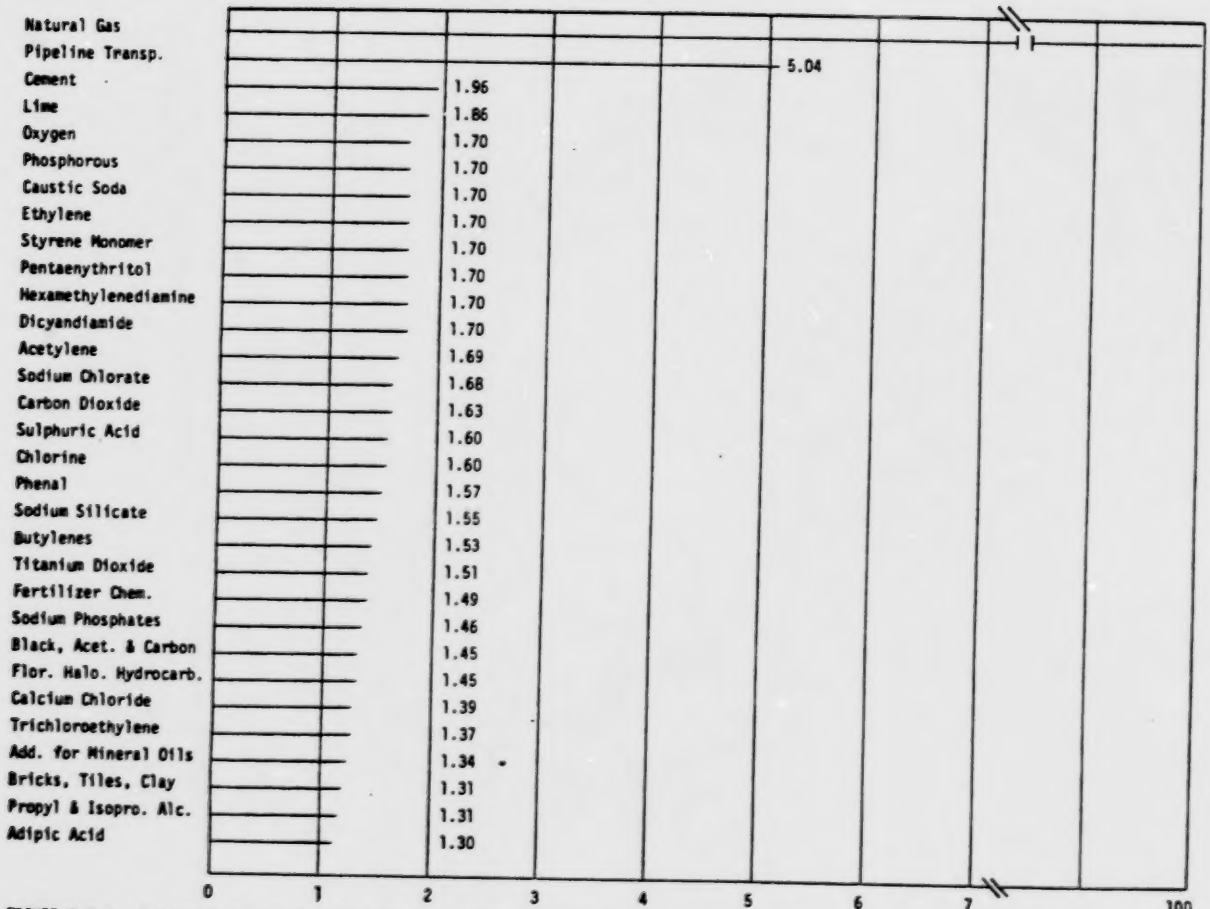



FIGURE 4.4.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of the Domestic and Import Prices of Natural Gas: Simulation 4(1971).

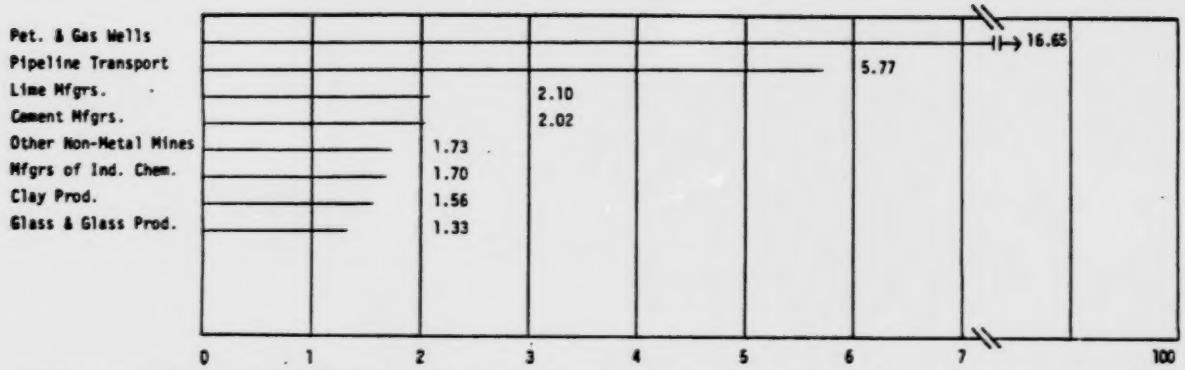



FIGURE 4.4.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of Both the Domestic & Import Prices of Natural Gas: Simulation 4 (1971)

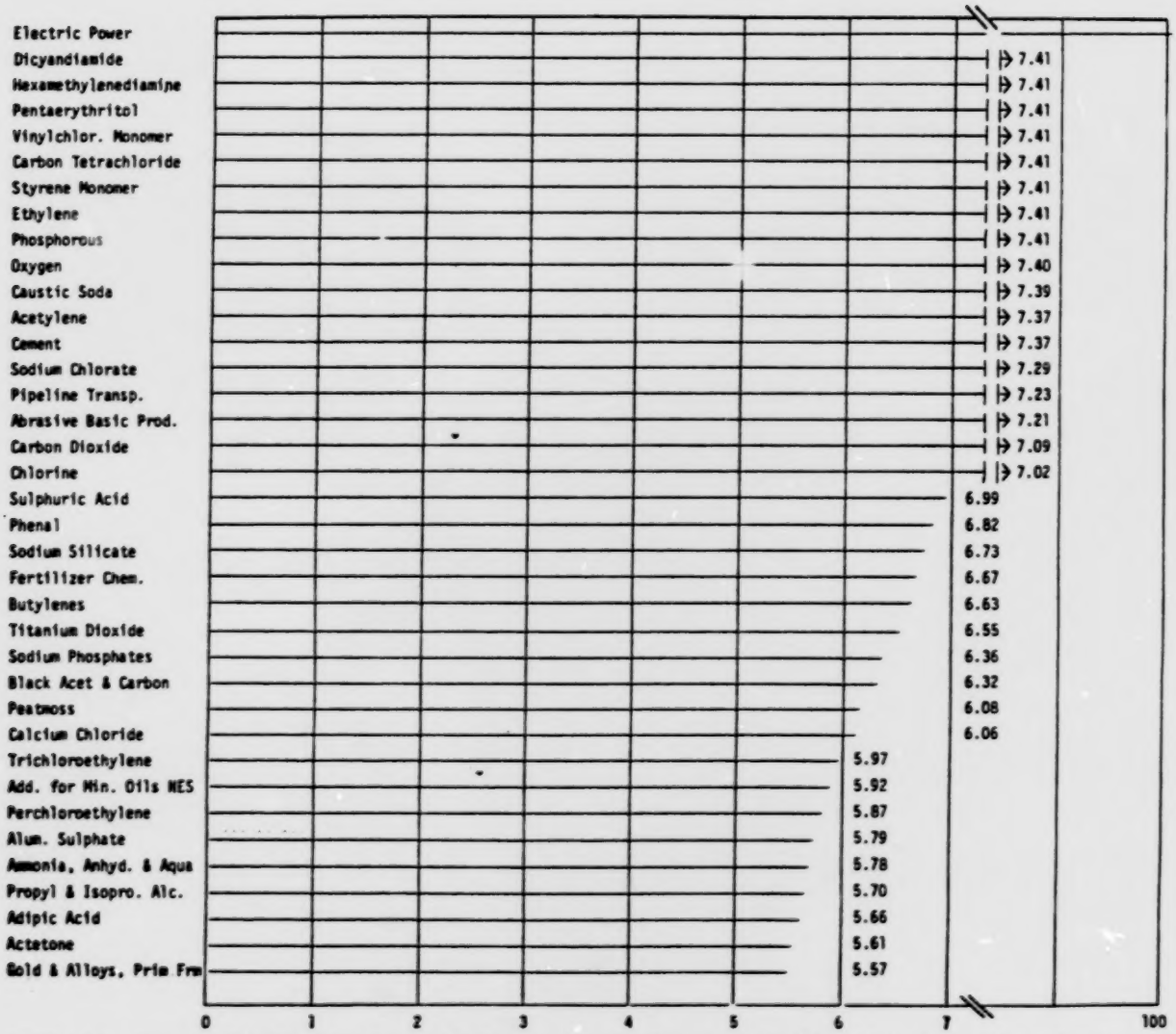



FIGURE 4.5.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of Both the Domestic and Import Prices of Electric Power: Simulation 5 (1971)

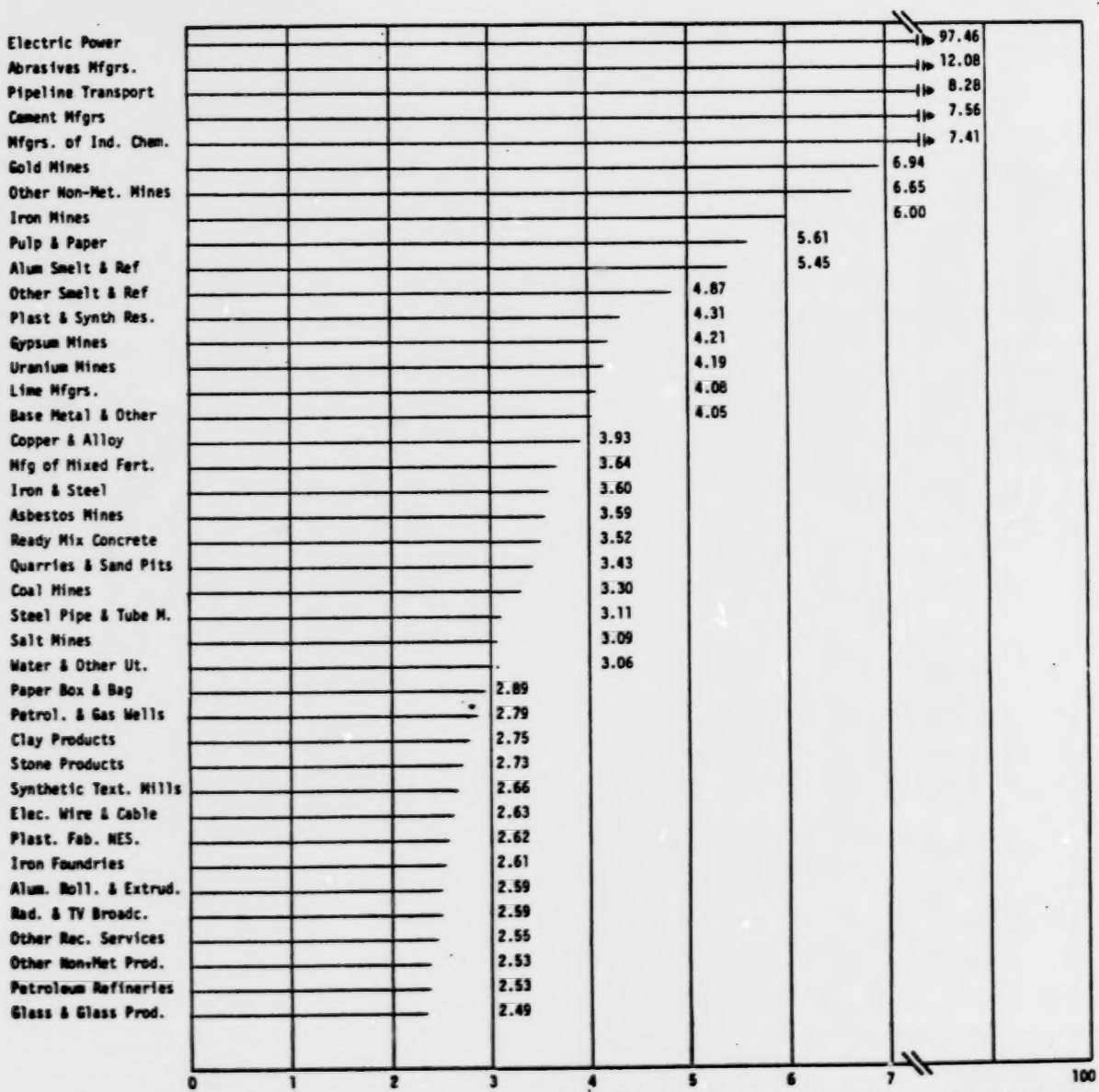



FIGURE 4.5.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of Both the Domestic & Import Prices of Electric Power: Simulation 5 (1971)

greater than 7 percent. Pipeline transport commodity prices increased by 7.2 percent. Of the industries, abrasive manufacturers increased by over 12 percent, pipeline transport by 8.2 and cement manufacturers by 7.5. The pulp and paper industry ranked ninth[17], with 4.6 percent. The CPI rose by 2.5 percent. It is interesting to note the high rise in clothing costs. These rose by 1.2 percent, and are likely to have been affected by the impact of electricity costs on the chemical products. Housing costs, at 5.4 percent, were the item registering the highest increase, a result likely due to higher electricity charges for heating and lighting and increased building costs.

Simulation 6 (Figures 4.6.A and 4.6.B) showed that a doubling of the price of radioactive ores had slight price impacts. The electric power commodity was ranked twelfth with an increase of 0.78 percent, while the electric power industry was ranked fourth, with an increase of 0.8 percent. These figures underline the fact that in 1971 nuclear plants were a small proportion of the electric generating capacity.

In Simulation 7 (Figures 4.7.A and 4.7.B), recognition was given to the possibility that oil and gas prices might rise together. They were both doubled, the result of which motor gas commodity prices increased by 66 percent, followed by fuel oil prices (60 percent) and petrochemical feedstocks (56 percent). The prices of the industrial chemical group of commodities formed the greatest number in the figure. The industrial price increases, as expected, showed petroleum and gas wells (93 percent) and petroleum refining (68 percent) at the head of the list. Ranked seventh was the lime manufacturing industry (6.7 percent), while agriculture was ranked twelfth with an increase of 4.2 percent. The CPI rose by 2.2 percent, with the transportation subgroup rising by 4.4 percent and housing by 2.5 percent.

Simulation 8 resulted in the most substantial price increase of the ten considered. In this simulation the domestic and import prices of coal, crude mineral oil, natural gas and

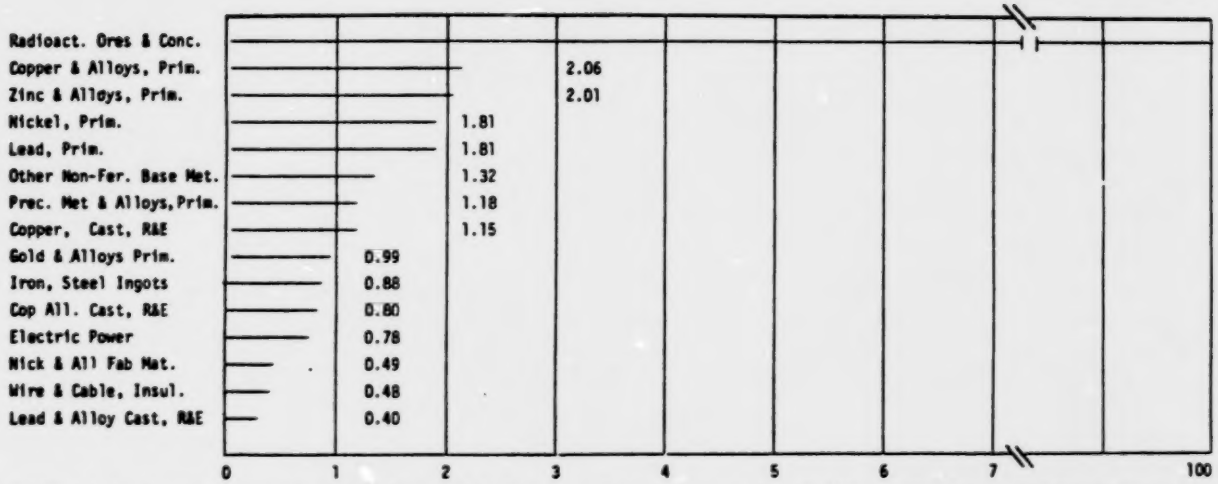



FIGURE 4.6.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of the Domestic and Import Prices of Radioactive Ores and Concentrates: Simulation 6 (1971)

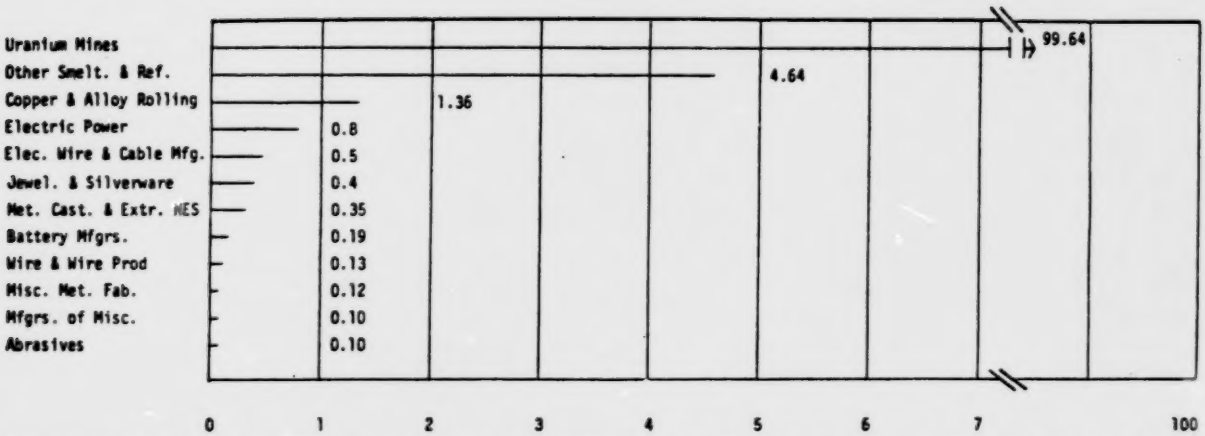



FIGURE 4.6.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of the Domestic & Import Prices of Radioactive Ores and Concentrates: Simulation 6 (1971)

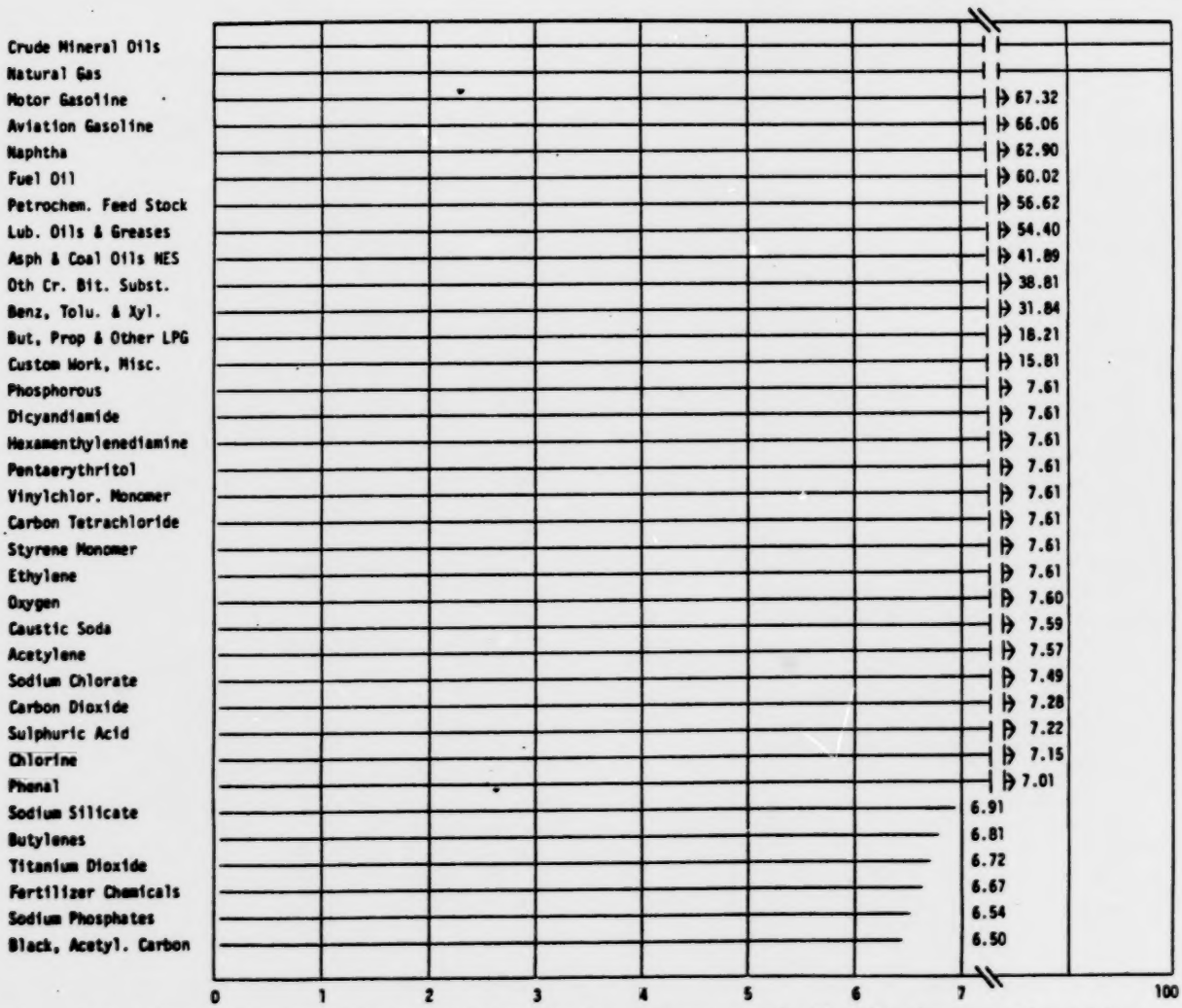



FIGURE 4.7.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of the Domestic and Import Prices of Crude Oil and Natural Gas: Simulation 7 (1971)

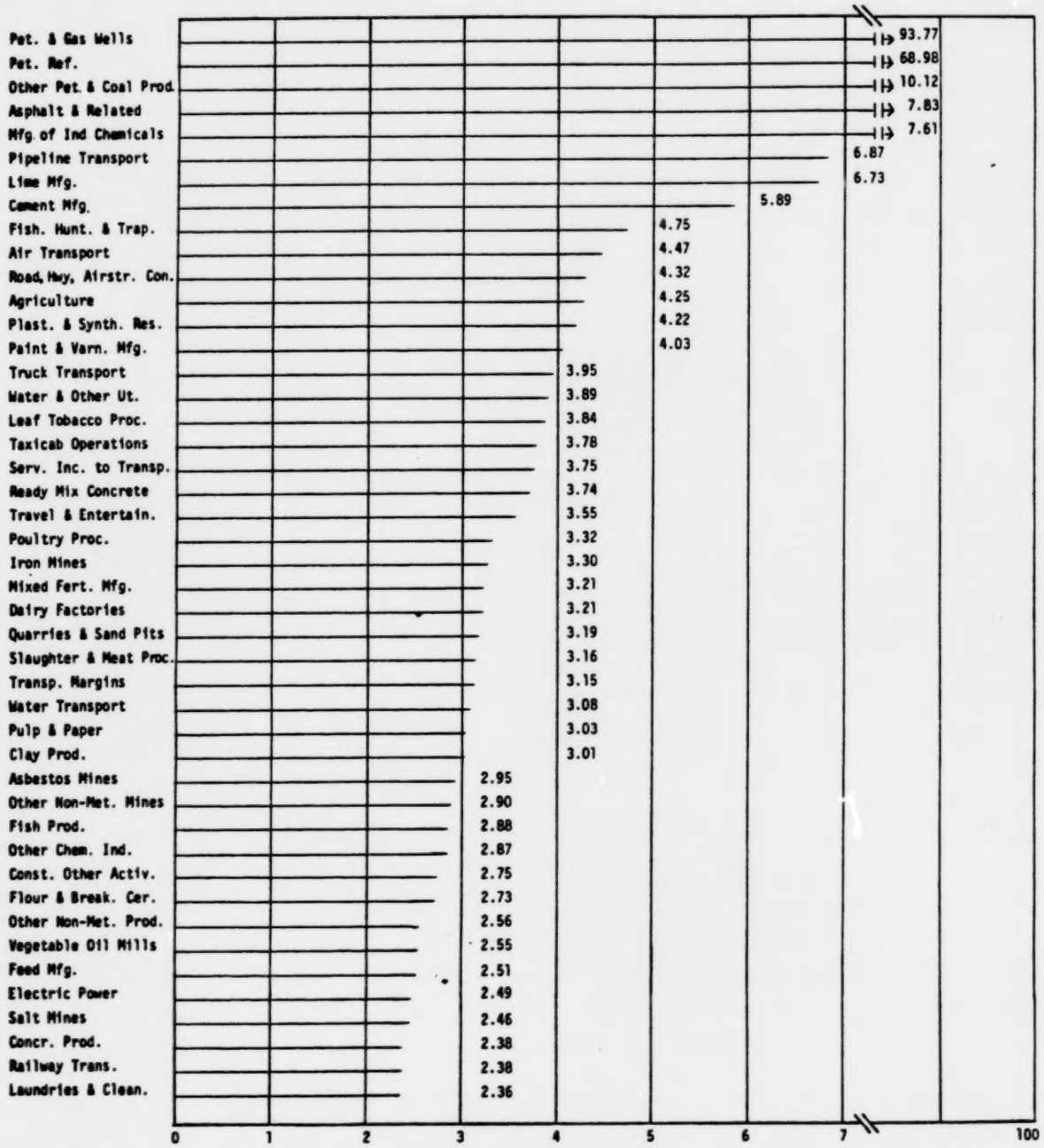



FIGURE 4.7.8: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of Domestic and Import Prices of Crude Oil and Natural Gas: Simulation 7 (1971)

electric power were all doubled simultaneously. As Figure 4.8.A shows, the secondary oil commodities of motor gas (68 percent) and aviation gasoline (67 percent) were ranked fifth and sixth respectively. Predictably, petrochemical feedstocks registered an increase of 58 percent (ranked ninth), while phosphates and cement prices rose by 15 and 14.5 percent respectively. The industrial price increases (Figure 4.8.B) showed the petroleum and gas well industry and the petroleum refineries in third and fourth rank. Note the high rank of the lime manufacturing industry (15 percent), the industrial chemical and the cement manufacturing industries, each with 15 percent respectively, and the iron and steel and the pulp and paper mill industry with 12 and 9 percent respectively. The agricultural industry was ranked twenty-eighth, with a price rise of 6.2 percent, followed by a group of the food processing industries, such as the poultry processors (5.4 percent), dairy factories (5.2 percent) and the slaughtering and meat processors (5.0 percent).

Despite the doubling in the price of the prime energy commodities,[18] the CPI rose by less than 5 percent (4.8 percent). Of the CPI items, housing costs rose by almost 8 percent, and food by 3.7 percent.

Simulations 9 and 10 consider the impact of doubling the prices of secondary energy commodities. The former doubles the prices of avaiation gasoline, motor gas and fuel oil, a group which approximates to the commodity gasoline and fuel oil in the M aggregation. Simulation 10 doubles the prices of other petroleum and coal products.[19] Among the commodity prices showing the largest increases in Simulation 9 (Figure 4.9.A) were air transport, lime, truck transport, wheat, milk, hogs, poultry and cattle and calves. Industry prices in air transport (6.7 percent), lime (6.7 percent), cement (5.7 percent) and agriculture (5.1 percent) headed the list shown in Figure 4.9.B. Not surprisingly, transportation showed the largest rise among the subgroups of the CPI index, followed by housing with 3.0 percent and food with 2.4

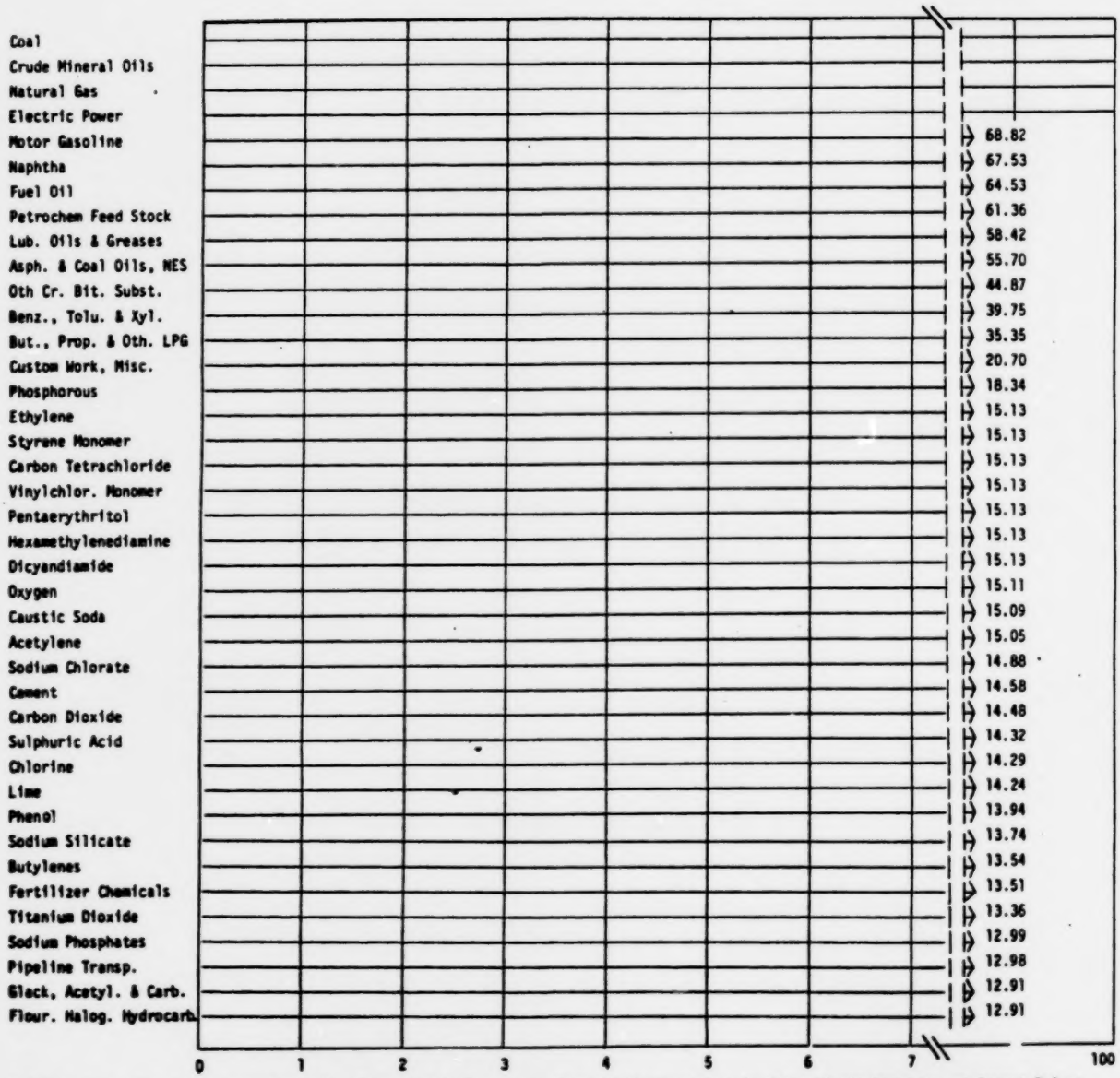



FIGURE 4.8.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of the Domestic and Import Prices of Coal, Crude Oil, Natural Gas and Electric Power: Simulation B (1971)

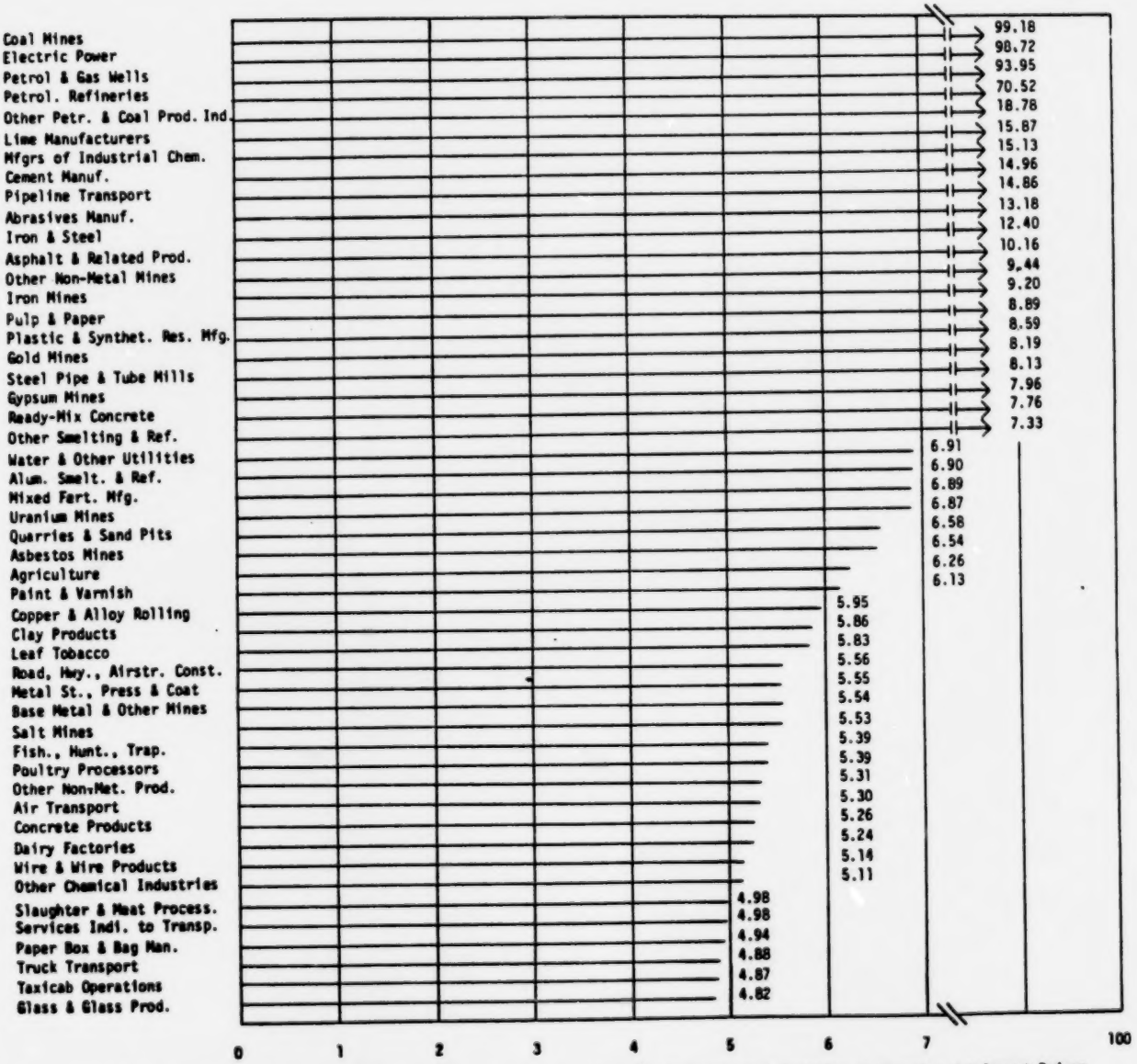



FIGURE 4.B.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of Domestic and Import Prices of Coal, Crude Oil, Natural Gas and Electric Power: Simulation B (1971)

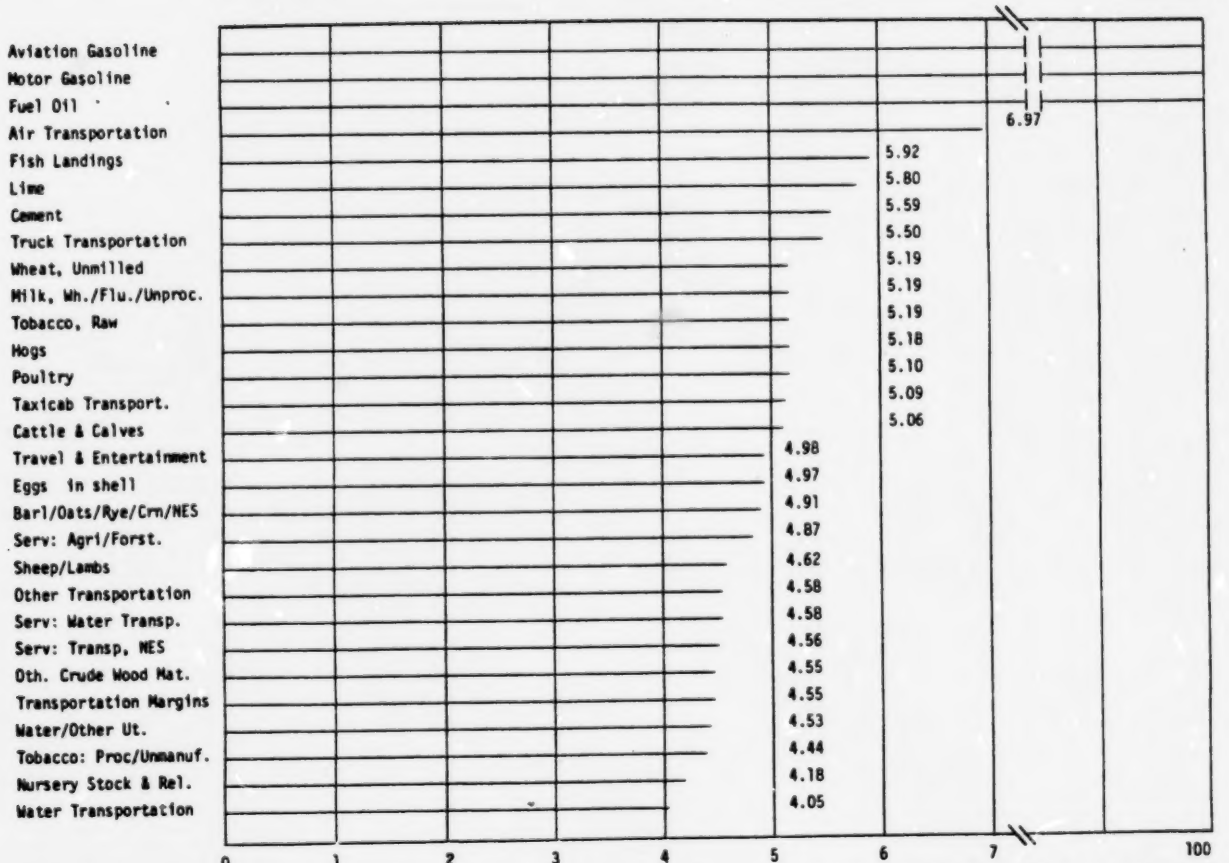



FIGURE 4.9.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of Both the Domestic and Import Prices of Aviation Gasoline, Motor Gasoline and Fuel Oil: Simulation 9 (1971)

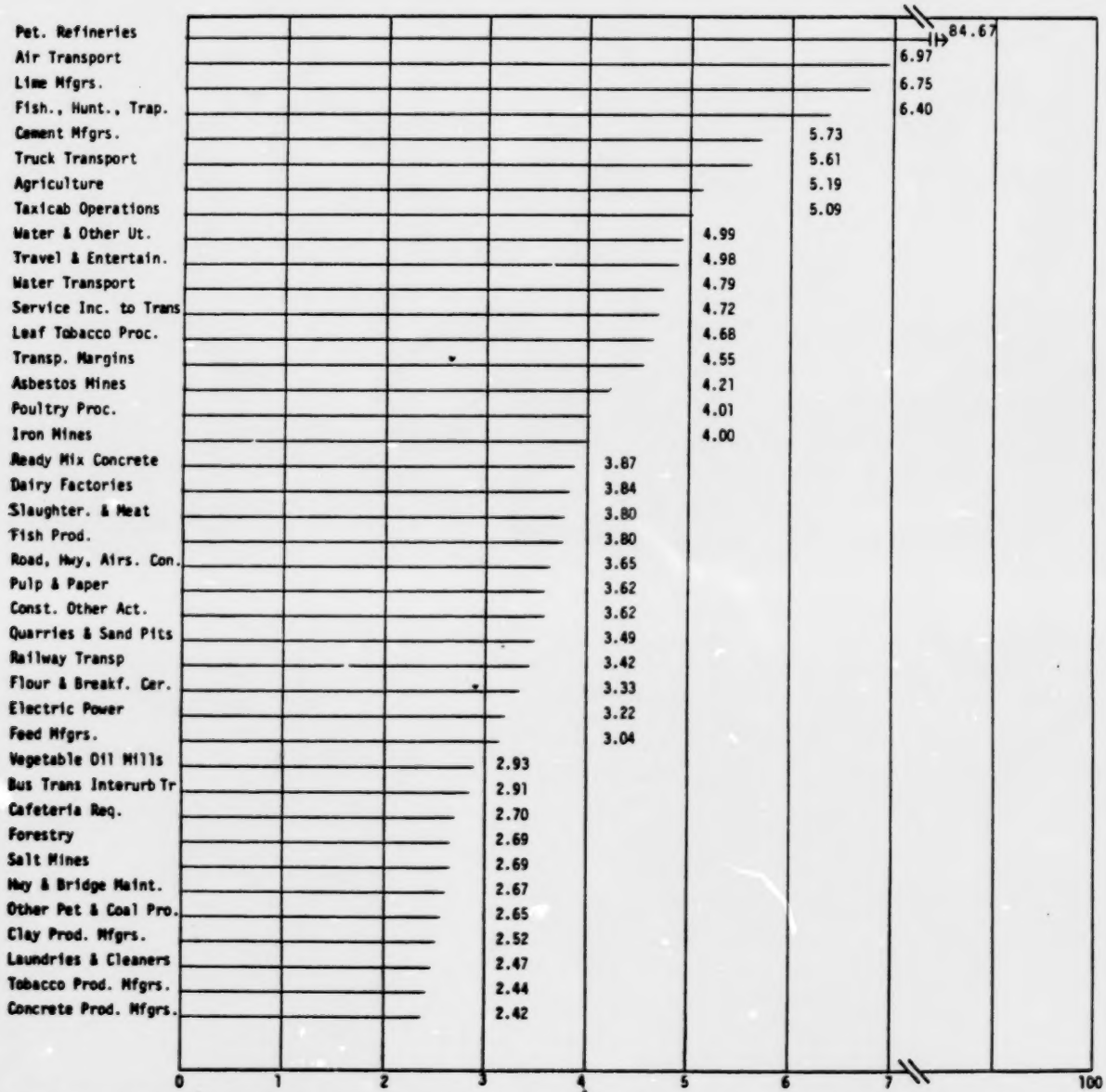



FIGURE 4.9.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of Both the Domestic and Import Prices of Aviation Gasoline, Motor Gasoline and Fuel Oil: Simulation 9 (1971)

percent. The CPI index itself rose by 2.7 percent. Simulation 10 produced a much lower increase in the CPI, some 0.4 percent. In the commodity price increases (Figure 4.10.A), the largest increases were found among the chemical products. Similarly, chemical industries ranked high in Figure 4.10.B.

A number of general observations can be made concerning the different impacts of the ten price simulations that were undertaken. Among the prime energy commodities, oil price increases produced the largest increases in gasoline and fuel oil commodities and industrial chemical commodities are high in the rankings. The largest increases in the prices of industrial outputs were in the industrial chemical industries and the non-metallic mineral producing industries. Natural gas price increases differed from oil price increases in that the commodity prices were much lower. Of these commodities, the cement and concrete products and industrial chemicals headed the rankings. In the case of coal price increases, the largest price effects were seen in the electric power and the iron and steel commodities.

Electricity price increases differed somewhat from the increases in the hydrocarbon energy group of commodities in that the industrial chemical group of commodities experienced the largest price increases. This group, as indicated above, also experienced large jumps in price in the oil and natural gas price simulations. In the electricity price simulation, however, this group of commodities dominated the rankings. When all the prime energy commodities were doubled, as they were in Simulation 8, the rankings of the commodity and the industrial price increases indicated the weight of the hydrocarbon energy commodities. Using the M commodity aggregation, the impacts on the commodity price increases in order of ranking were the gasoline and fuel oil commodities, the 'other petroleum and coal products' and the industrial chemical commodities. The impacts on the price of industrial outputs resulted in the petroleum and coal products industry ranked first, followed by the non-metallic mineral producing industries and the primary metal industries.

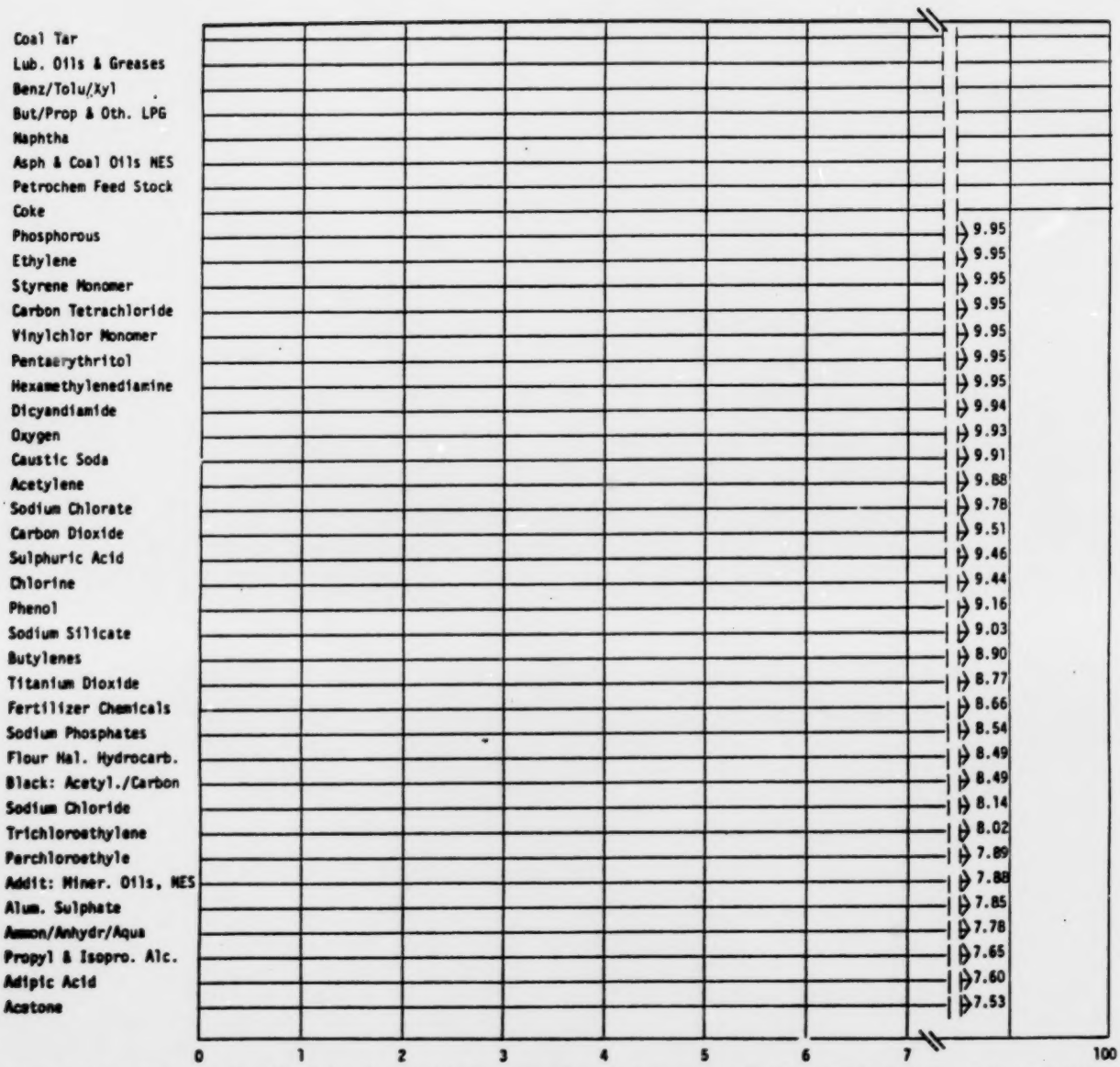



FIGURE 4.10.A: Changes in Commodity Prices Expressed in Percentage Terms in Response to a Doubling of Both Domestic and Import Prices of Gasoline, Fuel Oil and Other Petroleum and Coal Products: Simulation 10 (1971)

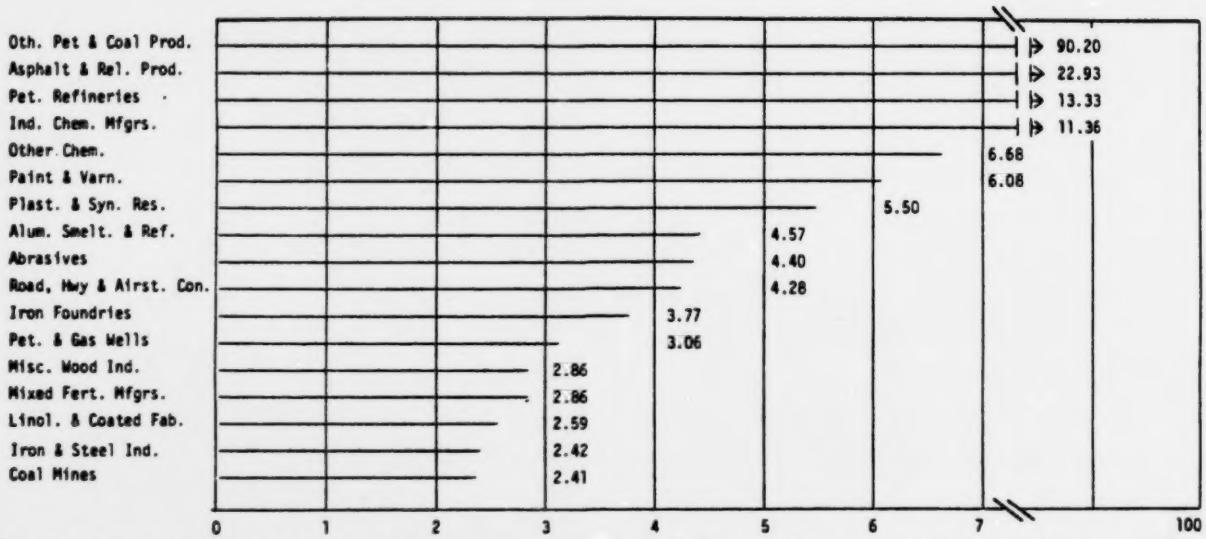



FIGURE 4.10.B: Price Changes in Industry Output Expressed in Percentage Terms in Response to a Doubling of Domestic & Import Prices of Gasoline, Fuel Oil and Other Petroleum and Coal Products: Simulation 10 (1971)

Simulations 9 and 10 considered the effects of doubling the prices of secondary energy, derived mostly from crude oil. Of particular interest were the impacts on grains and dairy product commodities of the price increases in Simulation 9. Both commodities were placed high in the rankings

Of the ten simulations, Simulation 8 led to the highest increase in the CPI. This was 4.8 percent. Examining the subgroups of the CPI, it will be seen that the energy price increase had greatest impact on transport, housing and food costs. The transport subgroup had the largest increase in five of the simulations, housing was first in four of the simulations, while food, in three of the simulations, came second.

## 4.3 The Impacts of the Simulations on Final Expenditure Prices

This section examines the impacts of energy price increases on final demand prices and then makes an attempt to measure the response that consumers are likely to make in response to the changes. The price model, when provided with the values for commodity and industry prices, calculates a variety of gross national expenditure and final demand price indices. There are three sets of indices which are of particular interest. The first is the consumer expenditure price index. This is a weighted sum of the commodity prices, the weights being derived from the total consumer expenditure coefficients. The second set of indices is the final demand price indices for each category of final demand.[20] The third index of interest is the GDP. This is calculated at market prices, in which the 1971 pattern of total final expenditures and the 1971 import proportions are used.

A summary of the impacts of the ten price simulations on these indices is displayed in Table 4.3. The changes in price indices follow the course described in the proceeding section. Simulation 8 displayed the largest increases, with a rise of 4.8

TABLE 4.3

CHANGES IN FINAL EXPENDITURE PRICE INDICES IN RESPONSE TO THE PRICE SIMULATIONS: 1971

| Price Index/ Simulation No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Consumer Expenditure | 1.9 | 1.4 | 0.4 | 0.2 | 2.6 | - | 2.2 | 4.83 | 2.7 | 0.4 |
| Machinery and Equipment | 0.5 | 0.3 | 0.3 | 0.1 | 0.7 | - | 0.6 | 1.52 | 0.6 | 0.2 |
| Construction | 1.2 | 0.9 | 0.5 | 0.1 | 0.9 | - | 1.3 | 2.72 | 1.2 | 0.9 |
| Government Current Expenditure | 0.6 | 0.5 | 0.2 | 0.1 | 1.2 | - | 0.7 | 2.11 | 0.9 | 0.1 |
| Export Price | 5.3 | 3.0 | 1.0 | 0.9 | 2.5 | 0.2 | 6.3 | 9.39 | 2.0 | 1.1 |
| Import Price | 3.5 | 3.5 | 1.0 | - | - | - | 3.5 | 4.73 | 0.8 | 0.4 |
| Gross Domestic Product at Market Prices | 2.4 | 1.7 | 0.5 | 0.2 | 1.7 | - | 2.6 | 4.74 | 1.8 | 0.5 |
| Total Final Expenditure | 2.2 | 1.4 | 0.4 | 0.3 | 2.0 | 0.1 | 2.5 | 4.74 | 2.0 | 0.5 |
| Average Price of Commodities | 2.2 | 1.6 | 0.4 | 0.3 | 3.0 | - | 2.5 | 5.54 | 3.1 | 0.4 |

percent in the final prices of consumer goods. In this simulation electricity and 'other fuel prices' headed the list, with increases of 94 and 40 percent respectively. Following these two were gas prices (28.7 percent) and gas, oil and grease prices (19.6 percent). The next group experienced much lower price increases. They were laundry and dry cleaning (4.6 percent), purchased transport (4.3 percent) and food and non-alcoholic beverages with an increase of 3.7. These three commodity groups, however, ranked high, behind the energy commodities, in all of the simulations. In Simulation 1, for instance, the price rise in laundry and dry cleaning (2.2 percent) exceeded the rise in electricity prices (1.9 percent).

In view of the importance of international trade to the economy, the impacts of the price changes on export prices are of particular interest. Note that Simulation 8 led to an increase in export prices of almost 10 percent. Doubling the price of oil (Simulation 1) pushed up export prices by 5.3 percent. When import prices of crude oil were doubled and domestic oil prices were held to a 50 percent increase (Simulation 2), however, export prices rose by 3 percent. Crude mineral oils, natural gas and electricity provide a substantial amount of exports, such that doubling the domestic prices of these commodities has had a direct effect of moving up the price index of exports. When these energy prices increase, so do the prices of those commodities which use directly and indirectly large amounts of energy. Such commodities, which are exported in substantial quantities, are of importance when analyzing the impact of energy price changes on export prices.

Four simulations have been considered for further detailed analysis. They are Simulations 1, 2, 5 and 8. The latter, because it has the largest impact on export prices, and the first two because they indicate interesting differences between oil pricing policies. Simulation 5 involves doubling electricity prices, an exercise which resulted in one of the highest export price increases. Table 4.4 presents commodities ranked according to the

TABLE 4.4

EXPORTS OF COMMODITIES IN 1971: DOMESTIC AND RE-EXPORTS
$M (current)

| Commodity Aggregation 'M' | Domestic Exports | Percentage of Total[a] | Cumulative Total | Re-Exports | Percentage of Total[b] |
|---|---|---|---|---|---|
| Motor Vehicles | 2661.3 | 12.9 | 12.9 | 7.7 | 1.8 |
| Motor Vehicle Parts | 1160.3 | 5.6 | 18.5 | 32.7 | 7.7 |
| Newsprint & O. Paper Stock | 1124.1 | 5.4 | 23.9 | 0.5 | 0.1 |
| Transportation Margins | 937.5 | 4.5 | 28.4 | 8.8 | 2.0 |
| Lumber & Timber | 798.0 | 3.8 | 32.2 | 0.2 | - |
| Grains | 794.7 | 3.8 | 36.0 | - | - |
| Crude Mineral Oils | 763.8 | 3.7 | 39.7 | - | - |
| Pulp | 756.7 | 3.6 | 43.3 | 0.1 | - |
| Wholesale Margins | 723.2 | 3.5 | 46.8 | 26.7 | 6.3 |
| O. Metal Ores & Concentrates | 590.8 | 2.8 | 49.6 | 0.3 | - |
| Nickel Products | 572.8 | 2.7 | 52.3 | 39.7 | 9.3 |
| O. Transport Equipment | 546.2 | 2.6 | 54.9 | 37.6 | 8.8 |
| O. Industrial Machinery | 472.4 | 2.3 | 57.2 | 77.6 | 18.3 |
| Transportation & Storage | 438.7 | 2.1 | 59.3 | - | - |
| Aluminum Products | 437.8 | 2.1 | 61.4 | 1.3 | 0.3 |
| Copper & Copper Alloy Prod. | 406.6 | 2.0 | 63.4 | 1.8 | 0.4 |
| Iron Ores & Concentrates | 351.3 | 1.7 | 65.1 | - | - |
| O. Electric Products | 346.7 | 1.6 | 66.7 | 24.6 | 5.8 |
| O. Non Ferrous Metal Prod. | 302.4 | 1.4 | 68.1 | 11.5 | 2.7 |
| Non Metallic Minerals | 271.4 | 1.3 | 69.4 | 4.6 | 1.0 |
| Iron & Steel Products | 270.8 | 1.3 | 70.7 | 12.0 | 2.8 |
| Industrial Chemicals | 263.4 | 1.2 | 71.9 | 4.8 | 1.1 |
| O. Agricultural Products | 262.8 | 1.2 | 73.1 | 2.7 | 0.6 |
| Pipeline Transportation | 248.1 | 1.2 | 74.3 | - | - |
| Fish Products | 245.3 | 1.1 | 75.4 | 2.1 | 0.5 |
| Cumulative Total | | 75.4 | | | |
| Total All Commodities | 20618.2 | | | 423.2 | 69.5 |

SOURCE: Statistics Canada Catalogue 15-506E Occasional [30], Table 87, page 317.

NOTES: [a]Domestic exports total $20618.2 million, of which $1787.2 are unallocated. This represents 8.6 percent of the total.
[b]Total re-exports sum to $423.2 million.

value of their exports in 1971. The top 25 commodities[21] out of 92 accounted for over 75 percent of all exports, while the top eight accounted for over 43 percent of all commodity exports.

The top ranking export commodities in 1971 were: motor vehicles, motor vehicle parts, newsprint and other paper stock, transportation margins, lumber and timber, grains, crude mineral oils and pulp, wholesale margins, other metal ores and concentrates and nickel products. These commodities accounted for over 50 percent of domestic exports in 1971. In moving to the L aggregation and selecting out commodities within this group which are exported in significant amounts, we are able to obtain estimates of the movements in prices. These are displayed in Table 4.5.

As Table 4.5 shows, the price of crude mineral oil prices in Simulations 1 and 2 changed from 100 percent to 74 percent. These were substantially higher than the price changes in the other selected commodities, and they clearly played a substantial part in the dip of the export prices from 5.3 to 3.0 percent. Of the other major export commodities, motor vehicle and engine parts dropped by 28 percent when the domestic price of oil dropped to 50 percent (Simulation 2). In Simulation 8 the increase in prices jumped up to 1.6 percent. These price increases, however, appear to be much lower than in the large group of commodities described as 'newsprint and other paper stock'. In this group, newsprint paper prices rose by 2.5 percent in response to Simulation 1, dropped to 1.8 percent in Simulation 2 and rose to over 8 percent in Simulation 8. As Table 4.4 indicates, the commodities grains, pulp and iron ores and concentrates join newsprint as those exported in substantial quantities and also sensitive to changes in oil prices.

An examination of Simulation 5 shows that doubling electricity prices increased export prices by 2.5 percent, somewhat lower than the results of doubling oil prices. This difference owes largely to the fact that in 1971 some $734 million of crude mineral oils were exported as against $43 million of electric

TABLE 4.5

CHANGES IN THE PRICES OF COMMODITIES IN RESPONSE TO SELECTED PRICE SIMULATIONS: SELECTED 1971 COMMODITIES WITH A HIGH EXPORT CONTENT

| Commodity/Simulation 'L' Aggregation | 1 | 2 | 5 | 8 |
|---|---|---|---|---|
| Motor Vehicle Engine & Parts | 0.3 | 0.2 | 0.7 | 1.6 |
| Newsprint Paper | 2.5 | 1.8 | 5.4 | 8.7 |
| Other Paper for Print | 2.1 | 1.6 | 4.6 | 7.4 |
| Lumber & Timber | 1.2 | 0.9 | 1.5 | 2.8 |
| Wheat | 4.0 | 3.0 | 2.0 | 6.2 |
| Barley, Oats, Rye, Corn & Grains | 3.8 | 2.8 | 1.9 | 5.9 |
| Crude Mineral Oils | 100.0 | 74.0 | 1.4 | 100.0 |
| Pulp | 2.2 | 1.7 | 4.9 | 7.8 |
| Nickel in Prime Form | 1.0 | 0.8 | 4.0 | 6.1 |
| Iron Ores & Concentrates | 2.4 | 1.8 | 5.2 | 8.0 |
| Bauxite & Aluminum | 0.2 | 0.1 | 0.7 | 1.0 |

NOTE: These are the prices for Pq, i.e., an index which is a linear combination of domestically produced commodity price indexes and import price indexes.

power. As Table 4.5 shows, with the exception of grains and crude oil all the high export commodities showed greater sensitivity to electricity prices than they did to similar increases in oil prices. Indeed, the impacts of these price changes owing to electricity prices contributed largely to the jump in export prices in Simulation 8. Note that when oil and natural gas prices increased together (Simulation 7), the export price index rose by 6.3 percent; while in Simulation 8 it rose by 9.39 percent.

In sum, oil, gas and coal commodities were exported in considerable quantities, with the result that raising the domestic and therefore the export prices had a direct effect on the export price index.[22] In contrast, electricity prices operated by raising the prices of those commodities which were also exported in considerable quantities. An examination of Simulations 1 and 2 suggests that keeping down domestic oil prices helps to keep down the costs particularly in the lumber and paper product industries and the motor vehicle engines and parts. It appears this operates not only by keeping down the prices of oil used directly by the industries producing these commodities, but also by keeping down the price of electricity, in whose generation substantial quantities of oil are used.

The rise in the prices of final consumer goods is likely to bring forth a response in demand from consumers. One can expect those commodities embodying more energy in their production to experience higher price rises when the price of energy increases. Faced with different price rises among the consumption goods, consumers are likely to respond by purchasing less of the more expensive and more of the less expensive goods. The extent of this substitution will depend on the price rises and the price elasticities of demand. These in turn will determine the extent to which the less energy intensive goods are substituted for the more energy intensive goods.[23]

Tables 4.6 to 4.9 present the results of an attempt to estimate the likely changes in consumer demand in response to the price changes produced by Simulation 8. This simulation has been selected because, of the ten simulations, it provides the largest increases in final demand prices. In Table 4.6 the levels of expenditure, prior to any price simulation, are listed for each category of expenditure. Alongside these expenditure figures are the changes in the prices of these expenditures in response to price Simulation 8. The next column presents estimates of the price elasticity of expenditures for almost all of the categories of expenditures. These estimates are for the short run price elasticities of expenditures and have been drawn largely from Schweitzer's work [45] and supplemented in part from other studies where they were thought to be appropriate. Table 4.7 contains the same information, except the elasticities are long-run measures. Details of the selection of the price elasticities are contained in Appendix E.

By multiplying the change in the price of the expenditure item by the price elasticity of expenditure it is possible to arrive at an estimate of the likely response in demand for the item. Such estimates are shown in the penultimate columns of Tables 4.6 and 4.7. The final column translates the percentage change in demand into actual dollar values by measuring expected changes in expenditure.

The measures of price change in the I-O model are assumed to occur instantaneously and there is assumed to be no substitution between factor inputs used in the production process. In the price elasticity estimates, the short run measures the reaction in the year the change occurs, while 'long run' refers to the new equilibrium level to which consumption of the goods or service are likely to settle after all the reactions to the initial changes have worked themselve out through the system. In this definition of long run, one of the assumed reactions would be a certain amount of substitution between factors by producers. This is not assumed in the I-O model's estimate of price changes, but alternatively,

TABLE 4.6

ESTIMATED SHORT RUN CHANGES IN THE DEMAND FOR FINAL CONSUMPTION GOODS AND SERVICES IN RESPONSE TO PRICE CHANGES IN ENERGY COMMODITIES: 1971, SIMULATION B

| Consumer Expenditure Category | Expenditures $ Million Current 1971 [1] | Changes in Prices of Final Demand In Resp. to Simulation B [2] | Estimated Short Run Price Elasticity [3] | Estimated Change in Demand (%) [2]x[3]=[4] | Estimated Change in Demand ($M, current '71 [1]x[4]=[5] |
|---|---|---|---|---|---|
| Food & Non-Alcoholic Beverages | 8182.389 | 3.74 | -0.48 | -1.79 | -146.464 |
| Alcoholic Beverages | 2111.241 | 1.36 | -0.14 | -0.19 | -4.011 |
| Tobacco | 1436.180 | 1.48 | -0.46 | -0.68 | -9.766 |
| Mens' & Boys' Clothing | 1234.831 | 2.03 | -1.33 | -2.70 | -33.340 |
| Womens' & Children's Clothing | 2315.478 | 2.06 | -1.33 | -2.70 | -62.518 |
| Footwear & Shoe Repair | 656.302 | 1.82 | -0.73 | -1.33 | -8.729 |
| Gross Imputed Rents | 5570.451 | 0.56 | -0.04 | -0.02 | -1.114 |
| Gross Paid Rents | 2884.954 | 2.36 | -0.01 | -0.02 | -0.577 |
| Other Lodging | 144.570 | 3.23 | N.A.[c] | -- | -- |
| Electricity | 858.657 | 94.96 | -0.14 | -13.29 | -114.116 |
| Gas | 276.177 | 28.70 | -0.15 | -4.30 | -11.876 |
| Other Fuels | 775.410 | 40.34 | -0.75 | -30.25 | -234.562 |
| Furn, Carpets & Floor Covering | 1151.825 | 2.42 | -1.01 | -2.44 | -28.105 |
| Durable Household Appliances | 795.153 | 2.30 | -0.63 | -1.45 | -11.530 |
| Semi Dur. House. Semi-Durable House. Furn. & Supplies | 1597.618 | 2.54 | -0.68 | -0.39 | -6.231 |
| Non-Durable Household Appliances | 779.893 | 3.82 | -0.88 | -0.09 | -0.702 |
| Laundry & Dry Cleaning | 257.243 | 4.63 | -0.93[c] | 4.30 | -11.061 |
| Domestic Services | 285.390 | 0.00 | -1.34 | 0.00 | 0.00 |
| Other Household Services | 106.428 | 1.61 | -1.34 | -2.15 | -2.288 |
| Medical Care | 556.925 | 1.02 | N.A. | -- | -- |
| Hospital Care | 326.977 | 3.07 | N.A. | -- | -- |
| Other Medical Care | 65.400 | 1.35 | N.A. | -- | -- |
| Drugs and Sundries | 717.102 | 2.67 | -0.15 | -0.40 | -2.868 |
| New & Used Automobiles | 2794.931 | 1.30 | -0.21 | -0.06 | -1.677 |
| Auto Repair & Parts | 1051.670 | 2.55 | -0.36 | -0.92 | -9.675 |
| Gas, Oil & Grease | 1444.677 | 19.65 | -0.10 | -1.96 | -28.316 |
| Other Auto Related Services | 579.774 | 2.29 | -0.36 | -0.82 | -4.754 |
| Purchased Transportation | 1003.840 | 4.30 | -0.23 | -0.99 | -9.938 |
| Communications | 905.427 | 1.19 | -0.09 | -0.11 | -0.996 |
| Rec. Sports & Camping Equipment | 1887.854 | 1.56 | -0.88 | -1.37 | -25.864 |
| Books, Magazines, Stationary | 633.325 | 2.39 | -0.48 | -1.15 | -7.283 |
| Recreational Services | 909.242 | 3.63 | N.A. | -- | -- |
| Education & Cultural Services | 1636.986 | 1.96 | N.A. | -- | -- |
| Jewellry, Watches & Repairs | 313.955 | 2.32 | -1.08 | -2.50 | -7.849 |
| Toilet Articles, Cosmetics, etc. | 452.528 | 2.71 | -0.20 | -0.54 | -2.444 |
| Personal Care | 496.227 | 1.92 | -0.47 | -0.90 | -4.466 |
| Exp. in Restaurants & Hotels, etc. | 3453.994 | 3.11 | -1.72 | -5.35 | -184.789 |
| Personal Business | 2742.808 | 1.68 | -0.25 | -0.42 | -11.520 |
| Oper. Exp. Non-Profit Organizations | 839.850 | 0.58 | -0.25[c] | 0.26 | -2.184 |
| Net. Expend. Abroad | 95.000 | 0.00 | -0.46 | 0.00 | 0.00 |
| TOTAL EXPENDITURE | 54328.6 | | | | -991.613 |
| LESS[b] | 3640.1 | | | | |
| NET EXPENDITURE | 50688.586 | | | | |
| PRICE ELASTICITY OF EXPENDITURE[c] | 0.405 | | | | |

SOURCE: Structural Analysis Division, Statistics Canada

[a]When the price elasticity estimates were not available or were implausibly large, they were marked N.A. - Not Available.

[b]This total represents those expenditure items for which price elasticities could not be obtained. These commodities accounted for 6.7 percent of total expenditures.

[c]This was obtained by dividing the percentage change in demand (i.e. -1.956 percent =-991.613:50688.5) by the percentage change in the price of the commodity expenditures; (i.e. 4.83 percent).

TABLE 4.7

ESTIMATED LONG RUN CHANGES IN THE DEMAND FOR FINAL CONSUMPTION GOODS AND SERVICES IN RESPONSE TO PRICE CHANGES IN ENERGY COMMODITIES: 1971, SIMULATION B

| Consumer Expenditure Category | Expenditures $ Million Current 1971 [1] | Changes in Prices of Final Demand In Resp. to Simulation B [2] | Estimated Long Run Price Elasticity [3] | Estimated Change in Demand (%) [2]x[3]÷[4] | Estimated Change in Demand ($M, current '71 [1]x[4]÷[5] |
|---|---|---|---|---|---|
| Food & Non-Alcoholic Beverages | 8182.389 | 3.74 | -0.55 | -2.057 | -168.312 |
| Alcoholic Beverages | 2111.241 | 1.36 | -0.16 | -0.218 | -4.603 |
| Tobacco | 1436.180 | 1.48 | -1.89 | -2.80 | -40.213 |
| Mens' & Boys' Clothing | 1234.831 | 2.03 | N.A.[a] | -- | -- |
| Womens' & Children's Clothing | 2315.478 | 2.06 | N.A. | -- | -- |
| Footwear & Shoe Repair | 656.302 | 1.82 | -0.73 | -1.33 | -8.729 |
| Gross Imputed Rents | 5570.451 | 0.56 | -1.30 | -0.73 | -40.664 |
| Gross Paid Rents | 2884.954 | 2.36 | N.A. | -- | -- |
| Other Lodging | 144.570 | 3.23 | N.A. | -- | -- |
| Electricity | 858.657 | 94.96 | -1.89 | -179.47 | -1541.032 |
| Gas | 276.177 | 28.70 | -0.6 | -17.22 | -47.558 |
| Other Fuels | 775.410 | 40.34 | -0.48 | -19.36 | -150.119 |
| Furn, Carpets & Floor Covering | 1151.825 | 2.42 | N.A. | -- | -- |
| Durable Household Appliances | 795.153 | 2.30 | -0.35 | -0.80 | -6.361 |
| Semi Dur. House. | | | -0.63 | -1.60 | -25.562 |
| Semi-Durable House. Furn. & Supplies | 1597.618 | 2.54 | -1.87 | -7.14 | -55.682 |
| Non-Durable Household Appliances | 779.893 | 3.82 | N.A. | -- | -- |
| Laundry & Dry Cleaning | 257.243 | 4.63 | -2.35 | 0.00 | 0.00 |
| Domestic Services | 285.390 | 0.00 | -2.35 | -3.78 | -4.023 |
| Other Household Services | 106.428 | 1.61 | N.A. | -- | -- |
| Medical Care | 556.925 | 1.02 | N.A. | -- | -- |
| Hospital Care | 326.977 | 3.07 | N.A. | -- | -- |
| Other Medical Care | 65.400 | 1.35 | -0.53 | -1.41 | -10.111 |
| Drugs and Sundries | 717.102 | 2.67 | -0.07 | -0.09 | -2.515 |
| New & Used Automobiles | 2794.931 | 1.30 | -0.36 | -0.92 | -9.675 |
| Auto Repair & Parts | 1051.670 | 2.55 | -0.18 | -3.54 | -51.142 |
| Gas, Oil & Grease | 1444.677 | 19.65 | N.A. | -- | -- |
| Other Auto Related Services | 579.774 | 2.29 | -0.67 | -2.88 | -28.911 |
| Purchased Transportation | 1003.840 | 4.30 | -0.36 | -0.43 | -3.893 |
| Communications | 905.427 | 1.19 | -2.39 | -3.73 | -70.417 |
| Rec. Sports & Camping Equipment | 1887.854 | 1.56 | N.A. | -- | -- |
| Books, Magazines, Stationary | 633.325 | 2.39 | N.A. | -- | -- |
| Recreational Services | 909.242 | 3.63 | N.A. | -- | -- |
| Education & Cultural Services | 1636.986 | 1.96 | N.A. | -- | -- |
| Jewellry, Watches & Repairs | 313.955 | 2.32 | -1.02 | -2.37 | -7.441 |
| Toilet Articles, Cosmetics, etc. | 452.528 | 2.71 | -3.04 | -8.24 | -37.288 |
| Personal Care | 496.227 | 1.92 | -0.90 | -1.73 | -8.585 |
| Exp. in Restaurants & Hotels, etc. | 3453.994 | 3.11 | -2.89 | -8.99 | -310.514 |
| Personal Business | 2742.808 | 1.68 | -0.60 | -1.01 | -27.702 |
| Oper. Exp. Non-Profit Organizations | 839.850 | 0.58 | N.A. | -- | -- |
| Net. Expend. Abroad | 95.000 | 0.00 | N.A. | -- | -- |
| | | | | | -2661.054 |
| TOTAL EXPENDITURE | 54328.686 | | | | |
| LESS[b] | 1362.38 | | | | |
| NET EXPENDITURE | 40696.30 | | | | |
| PRICE ELASTICITY OF EXPENDITURE[c] | -1.149 | | | | |

SOURCE: Structural Analysis Division, Statistics Canada

[a]When the price elasticity estimates were not available or were implausibly large, they were marked N.A. - Not Available.

[b]This total represents those expenditure items for which price elasticities could not be obtained. These commodities accounted for 25.1 percent of total expenditures.

[c]This was obtained by dividing the percentage change in demand (i.e. -6.5% = -2,661.054 : 40696.306) by the percentage change in the price of the commodity expenditures; (i.e. 5.65 percent).

TABLE 4.8

SHARE OF FINAL DEMAND COMMODITIES OF TOTAL FINAL EXPENDITURE BEFORE AND AFTER THE PRICE INCREASE RESULTING FROM SIMULATION 8: SHORT RUN PRICE ELASTICITIES

| Consumer Expenditure Group | Before the Price Increase | | After the Price Increase | |
|---|---|---|---|---|
| | $M | % of Total | $M | % of Total |
| High Price Response[a] (Above 19 percent) | 3354.942 | 6.6 | 2966.051 | 5.9 |
| Medium Price Response[b] (3 to 19 percent) | 13677.359 | 27.0 | 13324.405 | 26.9 |
| Low Price Response[c] (Below 3 percent) | 33656.285 | 66.4 | 33406.517 | 67.2 |
| TOTALS | 50688.586 | 100.0 | 49696.973 | 100.0 |

SOURCE: See Table 4.6

NOTES:

a The commodities included in this group were: electricity, other fuels, gas and gas/oil/grease.

b The commodities included in this group were: laundry and dry cleaning, purchased transport, food and non alcoholic beverages, non-durable household supplies and expenditure in restaurants and hotels, etc. Items which would have been included in this group but which had to be excluded because their price elasticities were not known were: recreational services, other lodging and hospital care. These items represented 27 percent of the total expenditure before the price increase.

c These commodities consisted of the rest of the commodities after the high and medium price commodities had been accounted for in the calculations.

TABLE 4.9

SHARE OF FINAL DEMAND COMMODITIES OF TOTAL FINAL EXPENDITURE BEFORE AND AFTER THE PRICE INCREASE RESULTING FROM SIMULATION 8: LONG RUN PRICE ELASTICITIES

| Consumer Expenditure Group | Before the Price Increase | | After the Price Increase | |
|---|---|---|---|---|
| | $M | % of Total | $M | % of Total |
| High Price Response[a] (Above 19 percent) | 3354.942 | 8.2 | 1565.091 | 4.1 |
| Medium Price Response[b] (3 to 19 percent) | 13420.116 | 33.0 | 12856.697 | 33.8 |
| Low Price Response[c] (Below 3 percent) | 23921.242 | 58.8 | 23613.458 | 62.1 |
| TOTALS | 40696.30 | 100.0 | 38035.246 | 100.0 |

SOURCE: See Table 4.7

NOTES:

a The commodity groups are the same as those in Table 4.8

b The commodity groups are the same as those in Table 4.8, except that there was no long run price elasticity available for the commodity 'laundry and dry cleaning'. Hence this had to be excluded in this calculation.

c Same as in Table 4.9, except that the following commodities were excluded owing to the lack of price elasticity estimates: clothing, gross rents paid, other auto related services, books, magazines and stationary, other non-profit organizations and net expenditure abroad.

the full impact of the price change occurs immediately. There is no time lag. As such, the time period implied by the I-O model does not fit comfortably into the definitions of short and long run price elasticities. For this exercise, therefore, we have included both short run and long run price elasticities.

An examination of the changes in prices shows the energy commodity price increases of Simulation 8 reflected in the larger price increases of electricity, gas, other fuel prices and gasoline. Other high price increases were other purchased transport, food and non-alcoholic beverages and laundry and dry cleaning. The highest long run price elasticities used were in domestic and other household services, recreation, sports and camping equipment. These were price elastic, as was the assumed price elasticity for electricity (1.89). Not surprisingly, the price elasticity of electricity and the high change in its price brought forth the largest expected change in demand.

There is some evidence to suggest that after the large oil price increases over the period 1973 to 1975 there were negligible shifts in the demands away from the products of the high energy intensive into the lower energy intensive commodities.[24] Of the 40 expenditure items, 6 accounted for 50 percent of the total expenditures in 1971. Food and non-alcoholic beverages (15 percent), gross imputed rents (10 percent), gross paid rents (5 percent), new and used autos (5 percent), restaurants and hotel expenditures (6 percent) and personal busines (5 percent). The changes in the prices of these items and their price elasticities will clearly be important in determining the changes in the mix of expenditure. The actual weight going to each item, however, has been affected by the lack of acceptable price elasticities for some of the expenditure items. Six such elasticities were missing from the column of short run price elasticities, accounting for 6.7 percent of total final consumer's expenditures in 1971. There were 15 long run price elasticities missing, accounting for a quarter of

the total final consumer's expenditures. The size of the latter necessitated weighting the changes in price by including only those commodities for which there were elasticities. As the calculations at the foot of Table 4.7 show, the rise in price of these was 5.65 percent.

A comparison of the short and the long run price elasticity measures shows that a doubling of the price of the prime energy commodities is likely to reduce final consumer expenditure in the short run by 1.9 percent and in the long run by 6.5 percent. This difference between the long and the short run is illustrated also by the likely shifts in the mix of expenditures. Tables 4.8 and 4.9 divide the consumer expenditure categories according to those which experience a high, medium and low price increase. As Table 4.8 illustrates, despite a doubling of the price of prime energy commodities, the share of final expenditure accounted for by those commodities with a high price response falls only slightly, from 6.6 to 5.9 percent. Similarly, the items in the medium price range showed only a slight drop in their share, although this drop is likely to be somewhat underestimated owing to the exclusion of those items for which no price elasticities were available. Table 4.9 records the shifts in market share using the long run price elasticities. Those items in the high price range have their share halved, from 8.2 to 4.1 percent. Those in the medium range increased their share slightly although this measure is likely to be affected by those items which were excluded because they were without measures of long run price elasticity.

The items with the high price increases are those with the high energy intensities. The estimates above show that a doubling of the prices of the prime energy commodities will cause some shifting among the final expenditure items, but it is not likely to be substantial. Indeed, the rise in energy prices that have actually occurred over the period 1971 to 1975 appear not to have caused very substantial shifts in the mix of output.[25]

## 4.4 Results From Other Input-Output Studies

This section briefly examines the impacts of rising energy costs on the provincial economies and the United States. As Canada's largest trading partner, relative changes in price effects resulting from energy price increases may be able to indicate some of the likely implications of introducing different energy pricing policies. Comparisons, however, are sometimes imprecise, owing to the different aggregations employed in the tables. Of the two provincial studies examined, Ontario's consists of square matrices while Quebec's is very similar to the Statistics Canada rectangular tables of the national economy.

The Ontario I-O tables consist of 49 industries. They refer to the year 1965.[26] Melvin [43] used these data to estimate the likely effects on prices[27] of raising the costs (by means of a 100 percent tax) of hydrocarbon fuels by 100 percent. The Ontario I-O tables did not separate petroleum and natural gas, but included them along with coal in the industry described as 'petroleum refineries and coal products'. The table of total price effects showed that only one industry, the petroleum and coal industry, experienced price changes in excess of 10 percent. The median change in prices was 2.1 percent. Of the basic manufacturing industries, only in one of them, other primary metals, did total price changes reach above 3 percent.

Melvin then took the I-O tables from Canada and the U.S. and conducted the same experiment in order to compare the results with those he had found in Ontario. In using the 1961-65[28] sector I-O table for Canada he faced difficulties in obtaining a group of energy commodities comparable with Ontario's 'hydrocarbon fuels'. He chose the petroleum products industry as the most appropriate and increased the import and the export price of these commodities by 100 percent. He also faced the fact that industries in the national and the Ontario tables were aggregated while they were not in the national tables. The national industries were more disag-

gregated, so he handled this problem by forming weighted averages, the weights being the total shares of the industry.

By comparing the total price effects on the Ontario and the Canadian industries he found that Ontario was at a disadvantage in agriculture and the agricultural products sectors. On the whole, however, he concluded that the price increases on industries in Ontario would be lower than on Canadian industries.[29]

> ... even if Ontario were the only province in which petroleum price rises occur, the overall price effect for most industries would be very moderate.[30]

He conducted a similar exercise on the 1965 U.S. I-O tables. These tables consisted of 81 industries,[31] but the crude petroleum and natural gas products were placed together in the 'crude petroleum and natural gas' industry. When the domestic and import prices of this industry were doubled, of the 81 industries, only 18 had direct price effects greater than 0.1 percent. While these low price effects were partially owing to the greater disaggregation used in the U.S. tables, he suggested that there were only 12 industries in which the total effect in Canada was less than it was in the U.S.[32] This difference he suggested was a result of Canada's colder climate, and a 'lack of economy in the use of energy'.[33]

After suggesting that an overall increase in the price of petroleum will have a greater effect on commodity prices in Canada than in the U.S., he made the following statement concerning domestic oil pricing policies:

> If Canada adopts world prices for petroleum, as petroleum prices continue to rise Canada will find itself at more and more of a price disadvantage relative to the U.S. Of course, as we have already observed, the overall price effects are not large, and our evidence suggests that a 100 percent increase in the price of petroleum in both Canada and the U.S. would be about equivalent to a 1 percent price increase in the Canadian exchange rate.

> The conclusion to be drawn from this would seem to be that any industrial shifts generated by the petroleum crisis are likely to be because of either real or imagined shortages and not because of possible commodity price effects that increases in petroleum prices would generate.[34]

Using slightly more recent tables, two other studies suggest that the impacts of raising energy costs in the U.S. had only moderate price impacts. Carter [2], using 1967 I-O tables, computed the effects of a 100 percent tax on petroleum products. She suggests that such an increase would lead to a rise in all industry costs of 3.8 percent. If all fossil fuel prices had been doubled, as distinct from the doubling of oil and natural gas prices, industry prices would have risen by 8.1 percent. The impact on industrial prices ranged from a 14 percent increase in the chemical industry to less than 2 percent for tobacco manufacturers.

Kim [8] conducted a similar exercise on the same 1967 I-O tables. His study considered the effect on prices resulting from an increase in import prices of crude petroleum of 100 percent. The imports, in value terms, accounted for about 7 percent of total crude outputs in the year.[35] He also estimated the changes in a cost of living index which he constructed. With 1967 current consumption used as a weight in the index, he calculated that for a 100 percent increase in the import price of crude oil the consumer price index would increase by 0.17 percent.

Quebec's I-O tables are structured in a way similar to those of the national tables. It is a similarity which allows for more direct comparisons than those already mentioned in this section. An opportunity to consider comparisons has been provided by G. Martin's [6] use of the Quebec price I-O model. He used the 1966 data of that province to run a simulation in which the price of imported crude oil prices was increased by 100 percent while all other input prices were held constant. In that year Quebec import-

ed from abroad all the crude mineral oil used in the province. For most of the other provinces in Canada, either domestically produced crude mineral oil or a combination of domestic and imported oil was used. Prices of crude mineral oil differed between the regions to the east and to the west of the Ottawa Valley. Quebec, lying to the east of the line, enjoyed lower priced crude mineral oil than the regions of the west. Estimates[36] suggest that crude oil prices at the refinery gate in Montreal were 82 percent of the price of crude at Sarnia, Ontario.

In comparing the effects of doubling the price of imported oil in the Quebec economy with the effects of doubling the price of oil to the Canadian economy, two simulations were conducted on the tables for 1966. The prices of imported and domestic crude mineral oil were doubled and, in the second simulation, only the price of imported crude mineral oil was doubled. The latter considered the situation in which the government allowed the import prices of oil to rise but kept the price of domestic oil down. In this way the comparative disadvantage of Quebec vis-a-vis the rest of Canada, large areas of which were supplied by domestic oil, could be exposed. Since oil was derived from domestic and imported sources in other parts of Canada, the comparable position with Quebec would involve doubling the price of domestic and imported oil. In this way the price of oil to all other provinces would double, as would the price of oil to Quebec. There is one qualification, however, to this comparison. As mentioned earlier, the price of domestic oil west of the Ottawa Valley was priced higher than the imported oil. Therefore, to obtain comparable prices levels between Quebec and the rest of Canada would have necessitated increasing domestic oil prices by less than 100 percent. As this was not done,[37] the level of prices in the rest of Canada exceeded the price level in Quebec.

Tables 4.10 and 4.11 present the commodity and industry price changes in response to the three simulations. In Table 4.10 the effects of doubling the price of imported oil on Quebec

TABLE 4.10

CHANGES IN COMMODITY PRICES EXPRESSED IN PERCENTAGE TERMS: A DOUBLING OF THE QUEBEC IMPORT PRICES FOR CRUDE OIL COMPARED WITH A DOUBLING OF DOMESTIC AND IMPORT PRICES FOR CRUDE OIL AND A DOUBLING OF IMPORT PRICES FOR CRUDE OIL IN CANADA: 1966

| | | QUEBEC | CANADA [2] | | | | DIFFERENCES | |
|---|---|---|---|---|---|---|---|---|
| Quebec[2] Rank Number | Quebec Commodity Classification [1] | Percentage Price Increase Import | Rank Number | Percentage Price Increase D & M[c] | Rank Number | Percentage Price Increase Import | Import & Domestic | Import |
| 1 | Crude Oil | 86.92 | 1 | 100.00[c] | 1 | 43.21[c] | -13.08 | 43.71 |
| 2 | Natural Gas | 44.33 | 3 | 21.80[c] | 3 | 9.42[c] | 22.53 | 34.91 |
| 3 | Petroleum Refining | 39.82 | - | N.A. | - | N.A. | -- | -- |
| 4 | Other Petroleum Products | 39.11 | - | N.A. | - | N.A. | -- | -- |
| 5 | Petroleum Derivatives | 26.62 | - | N.A. | - | N.A. | -- | -- |
| 6 | Oils/Greases/Lubricants | 10.61 | 2 | 47.20[c] | 2 | 20.39[c] | -36.53 | -9.78 |
| 7 | Truck Transport | 4.89 | 6 | 3.89 | 6 | 1.68 | 1.00 | 3.21 |
| 8 | Inter-Urban Rural Trans. | 4.41 | 5 | 4.41 | 5 | 1.90 | 0.00 | 2.51 |
| 9 | Urban Transport | 4.41 | 19 | 2.30 | 19 | 0.90 | 2.11 | 3.51 |
| 10 | Taxicab Transport | 4.41 | 15 | 2.83 | 16 | 1.22 | 1.58 | 3.19 |
| 11 | Serv. Incidental to Trans. | 4.25 | 16 | 2.66 | 17 | 1.15 | 1.59 | 3.10 |
| 12 | Storage: Grain Elevators | 3.11 | 23 | 1.26[c] | 23 | 0.55[c] | 1.85 | 2.56 |
| 13 | Water Transport | 3.09 | 13 | 2.96[c] | 14 | 1.28 | 0.13 | 1.81 |
| 14 | Serv. Incid. to Water Trans. | 2.89 | 8 | 3.44 | 8 | 1.49 | -0.55 | 1.40 |
| 15 | Stone | 2.77 | 12 | 3.02 | 13 | 1.30 | -0.25 | 1.47 |
| 16 | Sand & Gravel | 2.65 | 14 | 2.85 | 15 | 1.23 | -0.20 | 1.42 |
| 17 | Trans. & Storage Margins | 2.34 | 11 | 3.15[c] | 12 | 1.36[c] | -0.81 | 0.98 |
| 18 | Air Transport | 2.32 | 7 | 3.86 | 7 | 1.67 | -1.54 | 0.65 |
| 19 | Serv. Incid. to Agricul. | 2.29 | 10 | 3.18[c] | 11 | 1.37[c] | -0.89 | 0.92 |
| 20 | Wholesale Trade Margins | 2.05 | 22 | 1.39 | 22 | 0.60 | 0.66 | 1.45 |
| 21 | Fish Processing | 2.00 | 20 | 1.98 | 20 | 0.86[c] | 0.02 | 1.14 |
| 22 | Chemical Fertilizer | 1.97 | 21 | 1.64[c] | 21 | 0.71[c] | 0.33 | 1.26 |
| 23 | Fish/Poultry/Eggs | 1.95 | 18 | 2.45[c] | 10 | 1.39[c] | -0.50 | 0.56 |
| 24 | Lime | 1.90 | 17 | 2.56 | 18 | 1.11 | -0.66 | 0.79 |
| 25 | Road/Hwys/Bridge Const. | 1.90 | 4 | 6.36 | 4 | 2.75 | -4.46 | -0.85 |
| 26 | Other Construction | 1.90 | 24 | 1.04[c] | 24 | 0.45[c] | 0.86 | 1.45 |
| 27 | Civil Engineering | 1.90 | - | N.A.[a] | - | N.A. | -- | -- |
| 28 | Auto Repairs | 1.88 | 26 | 0.27[c] | 26 | 0.12[c] | 1.61 | 1.76 |
| 29 | Livestock | 1.87 | 9 | 3.28[c] | 9 | 1.42[c] | -1.41 | 0.45 |
| 30 | Gas Distribution-Utility | 1.87 | 25 | 0.44 | 25 | 0.19 | 1.43 | 1.68 |

SOURCE: [1] The Quebec commodity classification and corresponding price increases were obtained from Martin, "Un Modele", pages 7-21.

[2] The percentage price increases for corresponding Canadian commodity classifications were obtained from Statistics Canada, Structural Analysis Division.

[a] N.A. - not available.

[b] Percentage price increases are ranked according to size under column 'Quebec Rank Number'. Other columns containing rankings are for the Canadian model. They contain rankings for top 30 Quebec commodity classes. (Only those commodity classes presented in the table relative to one another are ranked.)

[c] D denotes domestic and M denotes imports.

TABLE 4.11

PRICE CHANGES IN INDUSTRY OUTPUT EXPRESSED IN PERCENTAGE TERMS: A DOUBLING OF QUEBEC IMPORT PRICES FOR CRUDE OIL COMPARED WITH A DOUBLING OF DOMESTIC & IMPORT PRICES FOR CRUDE OIL AND A DOUBLING OF IMPORT PRICES FOR CRUDE OIL IN CANADA: 1966

| | | QUEBEC | CANADA [2] | | | | DIFFERENCES | |
|---|---|---|---|---|---|---|---|---|
| Quebec[2] Rank Number | Quebec Industrial Classification [1] | Percentage Price Increase Import | Rank Number | Percentage Price Increase D & M[c] | Rank Number | Percentage Price Increase Import | Import & Domestic | Import |
| 1 | Petroleum Products Industries | 61.85 | 2 | 67.20 | 2 | 29.04 | -5.35 | 32.81 |
| 2 | Truck Transport | 4.92 | 3 | 3.96 | 3 | 1.71 | 0.96 | 3.21 |
| 3 | Public Transit | 4.41 | 15 | 2.30 | 15 | 0.99 | 2.11 | 3.42 |
| 4 | Water Transport | 3.12 | 5 | 3.62 | 5 | 1.56 | -0.50 | 1.56 |
| 5 | Plastic & Synthetic Mfg. | 3.04 | 6 | 3.58 | 6 | 1.55 | -0.54 | 1.49 |
| 6 | Quarries & Gravel Pits | 2.77 | 7 | 3.57 | 7 | 1.54 | -0.80 | 1.23 |
| 7 | Air Transport | 2.32 | 4 | 3.95 | 4 | 1.71 | -1.63 | 0.61 |
| 8 | Fishing/Hunting/Trapping | 2.30 | 8 | 3.39 | 8 | 1.46 | -1.09 | 0.84 |
| 9 | Agriculture | 2.29 | 9 | 3.29 | 9 | 1.42 | -1.00 | 0.87 |
| 10 | Other Chemical Industries | 2.27 | 11 | 2.94 | 11 | 1.27 | -0.67 | 1.00 |
| 11 | Wholesale Trade | 2.05 | 23 | 1.26 | 23 | 0.54 | 0.79 | 1.51 |
| 12 | Civil Engineering[a] | 1.90 | - | N.A.[a] | - | N.A. | -- | -- |
| 13 | Other Public Services | 1.87 | 1 | 11.00 | 1 | 4.75 | -9.13 | -2.88 |
| 14 | Retail Trade | 1.82 | 27 | 0.94 | 27 | 0.41 | 0.88 | 1.41 |
| 15 | Rail Transport | 1.71 | 13 | 2.49 | 13 | 1.08 | -0.78 | 0.63 |
| 16 | Other Non-Metal Min. Industries | 1.69 | 19 | 1.76 | 19 | 0.76 | -0.07 | 0.93 |
| 17 | Cement & Concrete Industries | 1.68 | 14 | 2.41 | 14 | 1.04 | -0.73 | 0.64 |
| 18 | Pulp & Paper Mills | 1.52 | 16 | 2.24 | 16 | 0.97 | -0.72 | 0.55 |
| 19 | Dairy Products | 1.50 | 10 | 3.04 | 10 | 1.31 | -1.54 | 0.19 |
| 20 | Forestry | 1.44 | 17 | 2.03 | 17 | 0.88 | -0.59 | 0.56 |
| 21 | Personal Services | 1.33 | 29 | 0.75 | 29 | 0.32 | 0.58 | 1.01 |
| 22 | Sawmills | 1.29 | 21 | 1.65 | 21 | 0.71 | -0.36 | 0.58 |
| 23 | Non-Metal Mines | 1.26 | 22 | 1.61 | 22 | 0.69 | -0.35 | 0.57 |
| 24 | Meat Industries | 1.25 | 12 | 2.56 | 12 | 1.10 | -1.31 | 0.15 |
| 25 | Postal Services | 1.23 | 28 | 0.90 | 28 | 0.39 | 0.33 | 0.84 |
| 26 | Paper Products | 1.13 | 20 | 1.68 | 20 | 0.72 | -0.55 | 0.41 |
| 27 | Broadcasting & T.V. | 0.94 | 26 | 0.97 | 26 | 0.42 | -0.03 | 0.52 |
| 28 | Hotels & Restaurants | 0.88 | 24 | 1.14 | 24 | 0.49 | -0.26 | 0.39 |
| 29 | Bakeries | 0.84 | 18 | 2.01 | 18 | 0.87 | -1.17 | -0.03 |
| 30 | Metal Mines | 0.84 | 25 | 1.13 | 25 | 0.49 | -0.29 | 0.35 |

SOURCE: [1] Martin, "Un Modele", pages 7-21.

[2] Statistics Canada, Structural Division.

[a] N.A. - not available.

[b] Percentage price increases are ranked according to size under column 'Quebec Rank Number'. Other columns containing rankings are for the Canadian model. They contain rankings for top 30 Quebec commodity classes. (Only those commodity classes presented in the table relative to one another are ranked.)

[c] D denotes domestic and M denotes imports.

commodities have been ranked in descending order of magnitude. Thirty such commodities, whose price increases exceeded 1.86, were included. The oil commodities experienced the highest price increases, but of the non-oil commodities, the highest price increase was recorded by truck transport, but with less than a 5 percent increase. The two simulations conducted on the Canadian data are also shown, along with their rankings. The rankings differ somewhat, and there are also differences in the commodity aggregations. The most conspicuous difference occurred in the Quebec commodity groups 'Petroleum Refining' and 'Other Petroleum Products'. In the Canadian L aggregation these two groups are broken down into a much smaller set of commodities. Instead of aggregating in an arbitrary way, the comparison was not registered.

A comparison between the Canadian and Quebec price effects is shown in the last two columns of Tables 4.10 and 4.11. The Canadian price impacts are deducted from the Quebec price effects, a negative indicating that the Canadian price increases exceeded those for comparable commodities and industries in Quebec. An examination of the effects of doubling the Canadian import prices shows, not unexpectedly, that Quebec would have experienced higher price increases than the rest of Canada. There are, however, a number of commodities and industries which show a lower price rise in Quebec than in the rest of Canada. The most interesting of these is the industry 'Other Public Services' (Table 4.11). This industry comprises of the electricity and gas utilities. It would appear that Quebec's use of hydro power was such as to diminish the increase in cost of generation which was felt more strongly in the rest of Canada where oil powered thermal plants provided a substantial proportion of the electricity generation.

This industry again appears in the next column of Table 4.11 as a high negative number. The column registers measures of the price increase in Quebec industries minus the price increases in Canadian industries brought about by doubling both the domestic and import price of oil. As would be expected, this column shows a

larger number of negative numbers than the previous column, which compared price increases resulting from increases in the price of imported oil.[38] The negative statistics imply that, if such pricing action had taken place, the prices in Canadian industries and commodities would have exceeded those in Quebec.

A comparison of the differences in the prices of commodities (Table 4.10) shows that Quebec would have a price advantage in the oil commodities, air transport, building materials (lime, sand and gravel) and some agricultural and food commodities. It would experience higher prices than the rest of Canada in transport services and chemicals. Of particular importance to the trade of the province, however, are those commodities which it exports and imports in substantial quantities with the rest of Canada and the rest of the world. Details of such commodities for 1966 are displayed in Table 4.12, along with the trade balance in each of the commodities.

Table 4.12 shows that Quebec was a large exporter abroad of pulp and paper (24 percent of the province's foreign exports in 1966), copper and aluminum. Together, these three commodities accounted for 44 percent of the province's exports abroad. An examination of the effects of doubling the price of crude oil prices on these commodities in Quebec and Canada indicates that Quebec had the lower price increases. Pulp and paper prices rose by 1.3 percent in Quebec and 2.05 percent in Canada. The estimates for copper were 0.52 and 1.92 percent respectively and those for aluminum were 1.22 and 1.42 percent. The effect of these increases suggests that Quebec would have been in a relatively more advantageous position than the rest of Canada in these three industries; a result, perhaps of using more hydroelectric power in these industries than in the rest of Canada. The advantage or disadvantage, however, would depend on the price of oil charged to competing industries abroad.

Of Quebec's major exports to the rest of Canada, clothing, with 11.5 percent of such exports, headed the list. An examination

TABLE 4.12

QUEBEC 1966: SELECTED IMPORTS AND EXPORTS OF COMMODITIES ($M CURRENT)

| Commodity | EXPORTS | | | | IMPORTS | | |
|---|---|---|---|---|---|---|---|
| | To Rest of Canada | % of Grand Total | Abroad | % of Grand Total | Imports | % of Grand Total | Trade Balance |
| Pulp & Paper | 133334 | 3.94 | 506567 | 24.26 | 69389 | 1.12 | +1077079 |
| Autos/Vehicles/Parts | 23976 | 0.71 | 81885 | 3.92 | 780004 | 12.61 | - 592258 |
| Copper | 91195 | 2.70 | 210313 | 10.07 | 81499 | 1.31 | + 430302 |
| Aluminium | 46925 | 1.38 | 217753 | 10.42 | 61542 | 0.99 | + 420889 |
| Clothing | 388487 | 11.50 | 15096 | 0.72 | 84438 | 1.365 | + 334241 |
| Metallic Minerals | 50572 | 1.50 | 169006 | 8.09 | 96108 | 1.55 | + 292476 |
| Agricultural Products | 4535 | 0.13 | 8350 | 0.39 | 277195 | 4.48 | - 264310 |
| Crude Oil/N. Gas/Serv. Inc. to Min. | -- | -- | -- | -- | 260438 | 4.21 | - 260438 |
| Iron & Steel | 54969 | 1.62 | 13684 | 0.06 | 332313 | 5.37 | - 249976 |
| Meat | 50919 | 1.50 | 18810 | 0.90 | 305707 | 4.94 | - 217168 |
| Other Food Products | 21024 | 0.62 | 1532 | 0.07 | 226460 | 3.66 | - 202372 |
| Electric & Telecommunications | 228866 | 6.7 | 62931 | 3.01 | 181962 | 2.94 | + 172766 |
| Petroleum Products | 63418 | 1.88 | -- | -- | 187105 | 3.02 | - 123687 |
| Industrial Chemicals | 60651 | 1.79 | 19433 | 0.93 | 173538 | 2.80 | - 93454 |
| Metallic Products | 240555 | 7.1 | 36484 | 1.74 | 246735 | 3.99 | + 66788 |
| Other Chemical Products | 136047 | 4.02 | 25374 | 1.21 | 217679 | 3.52 | - 30884 |
| Electricity[a] | 15949 | 0.47 | 248 | 0.01 | -- | -- | + 16197 |
| Total[b] | 1611422 | | 1379116 | | 3582112 | | |
| GRAND TOTAL[c] | 3376137 | | 2087991 | | 6183114 | | |

SOURCE: Lefort and Marshall, Le Tableau Economique du Quebec Statistiques.

[a] In 1966, Quebec exported 4,830,043 thousand kW.h of electricity and imported 11,615 thousand kW.h.

[b] 'Total' consists of a summation of the commodities presented in the Table.

[c] 'Grand Total' consists of a summation of all commodities imported to or exported from Quebec.

of the price impacts showed that the price of this commodity in Quebec would increase by 0.4 percent; while in Canada prices would rise by 0.58 percent. Quebec also had a price advantage in two other important export commodities: other metal products (0.36 percent as against 0.8 percent) and electric and telecommunications equipment (0.24 as against 0.21). These are, however, small price advantages, and could reflect the lower prices paid for oil in Quebec.

## 4.5 Summary

Of the ten price simulations conducted on the 1971 I-O tables, increases in the hydrocarbon energy group of commodities produced the largest price increases in gasoline, fuel oil, cement and industrial chemicals. In the case of coal price increases, the largest price effects were seen on the electric power and the iron and steel commodities. Electricity price increases differed somewhat in that the industrial chemical groups of commodities experienced the largest price increases. When all the prime energy commodities were doubled, as they were in Simulation 8, the rankings of the commodity and the industrial price increases indicated the weight of the hydrocarbon energy commodities. Using the M commodity aggregation, the impacts on the commodity price increases in order of ranking were the gasoline and fuel oil commodities, the other petroleum and coal products, and the industrial chemical commodities. The impacts on the prices of industrial output resulted in the petroleum and coal products industry being ranked first, followed by the non-metallic mineral producing industries and the primary metal industries.

Simulation 8 resulted in the highest price increases among commodity and industry prices [39]. It also resulted in the highest increase in the CPI, which was 4.8 percent. An examination of all of the simulations showed that the energy price increases had greatest impacts on transport, housing and food costs.

Simulation 8 also increased the index of final consumer prices 4.8 percent. Electricity prices rose by 94 percent and other fuel prices by 40 percent. Natural gas prices rose by 28.7 percent and gas, oil and grease prices by almost 20 percent. Three other commodity groups showed a high response to the energy price increases. They were laundry and dry cleaning, purchased transport and food and non-alcoholic beverages.

The impacts of the simulations on export prices showed electricity price increases to be of considerable importance. Oil, gas and coal commodities were exported in considerable quantities, with the result that raising the domestic and therefore the export prices raised directly the export price index. In contrast, electricity prices operated indirectly on prices. Electricity prices operated by raising the prices of those commodities whose costs were sensitive to electricity prices and were also exported in considerable quantities. Such commodities were motor vehicles, motor vehicle parts, newsprint and other paper stock, lumber and timber.

The response of demand to changes in the prices of final expenditure items suggested that it was not substantial. The doubling of the prime energy commodities (Simulation 8) caused the index of consumer expenditure to rise by 4.8 percent. The estimated short run fall in final expenditures in response to this increase in price was only 2 percent.

An examination of the effects of doubling the price of hydrocarbon energy commodities in Ontario in 1966 indicated that, apart from the oil commodities, the price increases were small. Only in primary metals did total price changes reach above 3 percent. On the whole, the price increases on industries in Ontario appeared to be lower than on Canadian industries. With the U.S., it appeared that there were only twelve industries in which the total effect on Canadian industries were less than they were in the U.S. Doubling import prices of crude oil in Quebec and then comparing the effects with a doubling of import and domestic prices

of crude oil in Canada showed that Quebec's main exports to the rest of Canada, namely clothing, electric products and metal products, would experience lower increases in price than similar commodities in Canada. It would appear that one of the reasons for the lower costs in Quebec was because a large proportion of electrical power generation came from hydro plants, and not from oil burning thermal plants.

In interpreting the results of the simulations, it should be recalled that the impacts of the price changes are assumed to occur simultaneously, in which no substitution of factor inputs takes place. As such, the impacts are likely to be overestimates of the price effects, for with large changes in price there is likely to be substitution of low for high energy factor inputs by industries and of low for high energy commodities by final consumers. In terms of their effects on price levels, the results, however, underestimate the effects they have on stimulating the costs of other factors to increase. For instance, the rising price of oil imports will affect the cost of other imports because oil is likely to be more expensive in the exporting countries. Rising energy costs will increase household costs and give a stimulus to wage increases. Such 'secondary or induced' effects of the energy price increase were not considered.[40]

## FOOTNOTES - CHAPTER 4

[1]See Sungwoo Kim [9] who has developed an I-O model which determines the output and employment multipliers directly from changes in import prices. In the model, changes in import prices are linked to final demands. The links are the price elasticities of consumption and exports. Changes in the demand for final goods and services affect the aggregate output and employment levels of the economy through the multiplier mechanism.

[2]The major findings are illustrated by the use of figures

[3]Oil imported into Montreal in the 1973/74 period rose by 208 percent. See Table 1.1. However, the prices paid by oil users did not rise by this amount, thanks to the subsidy programme that was introduced.

[4]See Ellison [15], Chapter 4 for a summary of the sources of these forecasts.

[5]In the L aggregation, Petroleum Refineries are numbered as 121, and Other Petroleum and Coal Producing Industries as number 122. See Table 2.1 for details.

[6]See Table 2.1 for details of the energy commodities used in the I-O tables.

[7]See Appendix A.

[8]See Appendix A, Table A.6.

[9]The other industries in which own generated electricity were of some significance were: the paper and allied industries and the chemical industries.

[10]See Appendix A.4.

[11]See equations 1.5.7 to 1.5.14.

[12]For a detailed description of the form in which the model is present consult Chapter 2 [34].

[13]The commodity prices refer to an index which represents a linear combination of domestically produced commodity price indexes and import price indexes.

[14]The value of MU in the simulation is 0.48. MU is the proportion of the total output of the commodity supplied by imports.

[15]Note that much of this coal is used as 'feedstock' and not directly as energy in the iron and steel industry.

[16]The other major effect will be via the increased price of electricity caused by higher coal prices.

[17]This is likely to be an underestimate owing to the fact that the I-O tables exclude own generated and used energy.

[18]In considering simulation 8, it is interesting to compare the results with Table 2.12, in which, it will be recalled, industries were ranked by their direct and total primary energy intensities. The prime energy used directly and that used indirectly to form the total energy were recorded for each industry (M aggregation) for the year 1966. Comparing Table 2.12 with Figure 4.8.B, some shifts in industry rankings can be noted. These could in large measure be due to the fact that the former was derived from a closed model in which only prime energy was considered while that of Figure 4.8.B was derived from an open model in which prime and secondary energy were included. In Figure 4.8.B the petroleum and gas wells and petroleum refinery industries are ranked third and fourth respectively, while in Table 2.12 the petroleum and coal products industry is ranked eighth. In the latter table primary metal industries are ranked first, while in Figure 4.8.B the iron and steel industry is ranked eleventh. Of particular note, however, are the high rankings attained by the chemical industries in Figure 4.8.B. The rise in the price of artifical fibres, in the production of which chemical commodities are important inputs, is no doubt in part responsible for the high ranking of textiles in the total energy intensity column of Table 2.12.

[19]These include the secondary energy commodities of: coal tar, lubricating oils and greases, benzene, butane, naphtha, asphalt and coke.

[20]With the exception of government revenue.

[21]Note that the exports in this table are according to the M commodity aggregation.

[22]It is also interesting to note that oil and coal were also imported in considerable quantities, whereas electricity was not. The result is that Simulations 1, 2 and 8 resulted in import price increases of 3.5, 3.5 and 4.73 respectively, while Simulation 5 resulted in no price increases.

[23]The substitution of the less for the more energy intensive goods after an increase in energy prices will take place at each level of production and not just in the final demand market. The direct and indirect demand for the energy intensive commodities will fall as less energy intensive commodities are substituted.

[24]It should be stressed that the estimates of the changing mix of final expenditures are presented as tentative measures. Some of the elasticities, for instance, have been taken from studies which have been measured on U.S. data. A further refinement would be to consider the cross price elasticities of demand between final commodities. Estimates of cross price elasticities, however, were not available.

[25]See Appendix F where the shifts in the market shares of (intermediate) industries are examined over the period 1966-75. Industries are ranked according to whether they are energy intensive and their market share is recorded. The evidence, drawn from census of manufacturing data, suggests that there were negligble shifts in demand away from the more to the less energy intensive commodities. Such findings suggest that the degree of substitution has been less than such commentators as Rose [12] had expected.

[26]See R.M. Frank, et al [4]. It would appear from published tables that a number of errors are contained in the printed tables.

[27]He also uses the price changes to make some preliminary estimates of their effects on income and employment.

[28]In his report, Melvin does not cite sources, but he does state that the I-O tables were for 1963. An examination of the tables suggests that they were for 1961, and drawn from [28].

[29]Since the Canadian figures include Ontario, the differences between Ontario and the rest of Canada would be somewhat greater than those shown. The comparisons in price effects on industries are shown in Melvin [43], Table 4.

[30]Melvin [43], page 41.

[31]No source was cited, but it appears that the source of the tables was the Survey of Current Business [35].

[32]See Melvin [43], Table 5.

[33]See Melvin [43], page 47.

[34]See Melvin [43], page 47.

[35]In 1966 the figure was 45 percent. The U.S. figure in 1978, however, is likely to be much higher than it was in 1967.

[36]See Ellison [15], Table 3.1. The average imported price of crude at Montreal in 1966 was $2.57 a barrel as against $3.12 a barrel at Sarnia.

[37]This was not done because of the lack of detail concerning the price of oil in all of the provinces of Canada in 1966.

[38]Note however, because initial Canadian domestic oil prices exceeded the import prices of oil into Quebec, the effects of doubling both export and import prices would tend to produce estimates which bias upwards the price effects on Canadian industries and commodities.

[39]It is interesting to note that if the energy commodities are compared with other commodities, their impacts do not appear to be substantial. See, for instance, Table D.5, which ranks the total impacts of commodities at the S level of aggregation. Note the low ranking of the mineral fuel commodities (27th in rank) and the petroleum and coal products, ranked 16th. Electric power, which is included in the aggregation 'other utilities' is ranked last.

[40]See G.V. Jump and T.A. Wilson [7] who used the Quarterly Forecasting model of the University of Toronto to estimate the 'direct' and the 'indirect' effects of increased crude oil costs. They compared a controlled solution of the model, which included the effects of the energy developments, with a solution of the model which excluded these effects. The difference between the solutions yielded the time profiles of the direct plus indirect effects of the energy 'crisis' in 1974 and the oil price increase on the Canadian economy. These results were described as follows:

> "the direct impact of higher petroleum prices caused the price index for total GNP to be an estimated 2.52 percent higher in 1974 than would otherwise have been the case. Indirect effects raised the price index in that year by an additional 0.72 percent, making the total impact in 1974 a 3.24 percent rise in the GNP price index. For 1975 the effect is expected to be even larger. The GNP price index is expected to be 5.25 percent higher in 1975 than would have been the case if the energy crisis had not occurred. Of this total, 2.84 percent will arise directly as a consequence of higher petroleum costs and the remaining 2.41 percent will occur via indirect effects.

Footnote 40 continued

Also shown in Table I (not included here) are estimates of the direct and indirect effects on the price index for personal consumption expenditures and on the implicit price indexes for total imports and exports. The direct effects for the latter two price indexes are substantially higher and occur sooner than those for the price indexes for GNP and consumer expenditures. This occurs because of Canada's dual price policy. Canada is both an importer and exporter of petroleum and import and export transactions take place at world petroleum prices, which are substantially above the domestic Canadian price.

Simulation results for other measures of macro-economic performance are presented in Table 2 (not included here). These results indicate that the increase in energy prices is having a substantial impact on the Canadian economy. What might appear unusual at first blush is the combination of reduced aggregate demand coincident with substantial inflationary effects on prices. This reflects in part the fact that the energy price hike exerts a cost-push inflationary effect--an effect which will generate a reduction in real demand as a by-product unless offset by expansionary monetary and fiscal policies. In addition, the slowdown in world economic growth brought about by the energy crisis and energy price increases is reducing real demand more directly by worsening Canada's export markets.

The effects upon real growth and employment are significant. Because of the energy crisis, real GNP in 1974 is reduced by 1.4 percent, and in 1975 by 3.1 percent. As a result of the slowdown in the growth of output, employment growth is also slowed. The effect of this is to cause an increase in the unemployment rate. During 1974 these effects are moderate because of the lags in the adjustment of employment to output changes. For 1975, however, the cumulative effects of the slowdown in growth result in an unemployment rate averaging 1.5 percent points higher than would otherwise be the case.

Clearly, the most significant impact of the energy developments is on price inflation. By the end of 1975, the price level is more than 5 percent higher as a result of the energy price hike and related developments. Furthermore, the end of the inflationary impact has not yet been reached: while wage inflation has responded to the tune of an acceleration of 0.8 percent per year by the end of the period, the lags in the structure of the wage/price spiral mean that the inflationary response will likely be more prolonged."

Pages 35 and 36, G.V. Jump and T.A. Wilson [7].

# APPENDICES

# APPENDIX A

## INPUT-OUTPUT TABLES: THE PROBLEMS OF VALUATION

### A.1 Introduction

Input-Output (I-O) analysis is concerned with the technical relationships of the process of production. The formulation and calculation of such relationships requires consistency in the method of valuation. If the relationships yielded are to be compared and supplemented by other industrial data then there is the need for these valuations to have a common basis with those of the I-O tables. Of particular interest is the possible use of census of manufacturing data, with its detailed energy use by province and industry, as a means of supplementing the national I-O tables. Unfortunately, the valuation procedures used in the census of manufacture differ considerably from those used in the I-O tables. It is the purpose of this appendix to outline these differences, and if possible, to produce a common basis of comparison between the two sets of information.

### A.2 Methods of Valuation: Producers' Prices and Purchasers' Prices

The valuation of the elements of the I-O table can be approached in two distinct ways. One way is to 'build upwards' from factor values while another way is to 'break down' from purchaser values. The latter method is employed in measuring the gross national expenditure, while the former is used to measure national

income and gross national product.[1] In compiling the I-O tables, the approach is also to build upwards from factor values.

The factor valuation of a commodity[2] involves the aggregation of the outlays spent on the factors of production (the prime inputs) used in producing the commodity along with intermediate inputs. Added to these direct intermediate inputs are the intermediate inputs used in each of the direct intermediate inputs, and so on. For example, the factor valuation of motor cars will involve the direct financial outlays to employees, the operating surplus and the consumption of fixed capital. Added to these prime inputs are the values of the steel, rubber, etc., used in producing the car (the direct intermediate inputs), and the steel, petroleum, etc., used in producing the direct intermediate inputs. Such financial outlays can be thought of as an infinite but convergent series. One of the contributions of the I-O techniques is to calculate these convergent series of outlays.

Taxes, subsidies and certain services introduce complications and lead to approximations. An understanding of the differences between the various measures of factor values and the approximations used requires a number of definitions. In the case of indirect taxes, two kinds are distinguished: net[3] commodity indirect taxes and other net indirect taxes. The former are related to the values (or quantities) of commodities sold or produced. They include such taxes as federal excise taxes, import duties and provincial sales taxes. The second group of taxes — other indirect taxes — are not identified with particular commodities. They include such taxes as motor vehicle licenses for businesses, property taxes, capital taxes and place of business taxes.

Certain services, such as those involved in transporting and distributing goods, are charged for by adding 'margins' to the producers' f.o.b. price. Sometimes these margins are difficult to detect, with the result that judgements have to be made when calcu-

lating them. The means by which these margins are measured is one way of distinguishing the two major methods of output valuation.

There are two major 'approximate' methods by which output is valued: by means of aggregating producers' values and by using purchasers' values. These two methods of valuation are distinguished by the definitions of producers' and purchasers' prices given in the introduction to the I-O tables:

Producers' Prices — The selling price at the boundary of the producing establishment excluding sales and excise taxes levied after the final stage of processing; equals purchasers' prices less transport, trade and commodity indirect tax margins where applicable.

Purchasers' Prices — The cost of goods and services in the market to the point of delivery to the purchaser. The purchasers' price can vary with circumstances, e.g. where the purchaser picks up the commodity at the producer's point of shipment rather than having it hauled by a common or contract carrier at the expense of the producer.[4]

The I-O tables consist of values calculated at producers' prices. Such prices, however, require not only the producers' prices of intermediate inputs but also calculations of service margins, many of which have to be measured by 'approximate' means. Two major groups of margins are considered: trade margins and transport margins (including pipeline, gas distribution and storage margins).

In the I-O tables[5] the wholesale and retail trade margins (gross margins) are calculated by estimating the value of sales less the cost of the goods purchased for sale. Such margins are separated from the values of the goods purchased by the producers in each industry group and appear in the tables as being purchased separately by the producers. The output (or margins) of transport services are measured by the revenue received by the carriers from

the users of the transport services. Those establishments oper ating their own transport services have their transport costs internalized in the operating costs of the establishment, such that their transport outputs are not recorded as 'transport commodities'. The margins of the storage industry are measured in two ways. Part of the output is calculated in the manner used to measure transport services, while part is allocated directly to the consuming industry in the same manner as other services purchased by these industries.

In considering commodity indirect taxes, the I-O tables make the distinction between commodity indirect taxes and other indirect taxes. The latter are treated as margins but the former, because they are difficult to identify with particular commodities, are shown as being directly paid by the industries.

In comparing the producers' and the purchasers' prices[6] in their function of valuing inputs and outputs, it is relevant to return to the objectives of I-O tabulations. One of their major objectives is to provide information with which to measure the technical relationship of the processes of production. The need is to have a set of values which provide a uniform measure. Commodities valued at producers' prices are exclusive of those indirect commodity taxes and service margins levied after the final stage of processing. This is in contrast to purchasers' prices, which consist of these taxes and margins added to the producers' prices. Since these trade margins and commodity taxes included in purchasers' prices vary considerably between purchasers,[7] they obscure the direct technical relationship between the inputs and outputs of the establishments. While producer prices provide a more direct measure than purchase prices, it is nevertheless a matter of degree. This is because producer prices include 'other' commodity indirect taxes in the price of intermediate inputs. As these cannot be allocated directly to particular commodities, they are added to the costs paid by the industry. Such taxes, however, also vary between purchasers, and so they serve to obscure the

sought after direct relationship between inputs and outputs. In sum, the Canadian I-O tables use valuations based on producer values. Hence, the intermediate inputs are recorded at producer prices, while the additional service and commodity indirect taxes costs incurred are recorded as separate margins, valued according to the producers' values of the transactions.

### A.3 Input-Output Valuations Compared With the Valuation Procedures Adopted in the National Income and Census of Manufacturing Tables

In view of the possible usefulness that census of manufacturing and national income data can give in adding coverage and regional details to the national I-O tables, this section explores some of the differences between the valuation procedures.

One of the major sources of differences between the I-O estimates and those made for the National Accounts arises from the use of the establishment as the basis of the statistical survey in the former and companies in the latter. Most of the company data are derived from taxation statistics, and these provide estimates of surpluses. In contrast, the establishment based surveys of surpluses are calculated in the context of a balance between inputs and outputs. This difference in the reporting unit can lead[8] to differences in industrial allocations of surplus such that a direct interchange with the two sets of data is questionable.[9]

The valuation procedure adopted in the census of manufacturing involves a number of approximations which result in valuations which differ considerably from those in the National Accounts and in the I-O tabulations. The cause of the difference has rested with the difficulty of deriving from establishment-based data estimates of gross domestic product at factor cost. Instead, the census of production and the subgroups of manufacturing industries have used what is termed the 'census value added' concept.

This is calculated by:

> ...deducting from gross value (exclusive of excise and other sales of finished goods and goods-in-process) or accrued operating revenue, the cost of intermediate materials and process supplies used, fuel and electricity consumed and charges.[10]

The census of value added method produces value added estimates for industries which differ from those in the gross domestic product tables. There are three reasons for these differences. Firstly, they contain net 'other' indirect taxes, such as property taxes. Secondly, the estimates include the cost of such services as advertising, insurance and communications. Thirdly, a number of differences between GDP estimates and census value added estimates arise because of the latter's use of the establishment as a reporting unit as opposed to the former's use of the company. To quote:

> A classification problem, however, is present in the published National Income and Expenditure Accounts current value GDP by industry estimates. Data for investment income (including profits) and for capital consumption allowances are collected and tabulated using the "company" as the basic statistical unit, while data for labour income and the inventory valuation adjustments are allocated on an "establishment" basis. Data for the net income of unincorporated business (including farm) do not fit into either of these categories. Thus no direct comparison is possible between the two sets of data.[11]

The census of manufacturing forms part of the census of production, and it can be seen that the valuation procedures of the one described above and that used in the national I-O tables differ in their treatment of service margins. In the census of manufacturing these are included in costs and in effect the valuation procedure adopted is that of the purchasers' valuation. Such differences in valuation procedures mean that in comparing the value added figures in the census of manufacturing with those in

the I-O tables, recognition has to be made of the varying incidences of service margins to the value added in different industries. For instance, in the census of manufacturing data, such service margins as insurance and advertising are likely to be higher in manufacturing industries than they are for agriculture and possibly the construction and extraction industries.

The I-O tables do provide separate estimates of service margins, and it would appear that these could be obtained from the tables and then extracted from the census of manufacturing estimates. In so doing, it would appear that comparable estimates of output and value added could be obtained from the I-O tables and the census of manufacturing data. Unfortunately, there are other differences between the data collection in the two sets of tables which preclude the execution of such an exercise with the published data. One of these differences concerns the handling of industries characterised by a high degree of vertical integration, such as the metal mining industry. To quote from the introduction to the I-O tables:

> Census of Mines have standardized all mine valuations by uniformly valuing all ores and concentrates, domestic and export, at a gross level of valuation. Matching smelting and refining charges are included on the input side of the prices. ... The Input-Output treatment involves placing a value on the production of the mine establishment at the ore and concentrate stage. This valuation is the net value of metals paid for, which is obtained by deducting the matching smelting and refining charges from the gross values of metals paid for. ... The domestic smelter and refining production data from the Census of Manufacture reflects a mixture of different transactions, since some produce only custom work while others input and output metals as goods purchased for resale (G.P.R.S.). The input-output treatment considers smelters and refineries as producers of metals, which are the actual commodities emanating from these establishments. These metals may be produced from domestic, imported ores and concentrates, and purchased scrap. The level of valuation of such metals is after the smelting and refining stage.[12]

The example given in the avove text is for the metal mining industry, and as the estimates for 1971 show in the footnote[13] the two estimating approaches can produce considerable divergencies in value. A further examination of comparisons in estimates between the I-O and the census of manufacturing data suggests that other manufacturing groups are also affected. One such industrial group, of particular interest to this study, is the petroleum and coal products industry.

The recall of the central interest of the study also serves to introduce an aspect of the data collection common to both the I-O tables and the census of manufacturing tables. It is that both sets of information do not include energy which is produced and then used within an establishment. In the case of the I-O tables, the measures of inputs record only the use of commodities actually purchased.[14] Those goods and services produced and used within an establishment are not registered as inputs. The classification of electricity generated and used within an establishment is worth quoting:

> Where electricity used by a manufacturing establishment is generated by the same establishment, electricity would not show as a commodity input, but the labour and material cost to produce the electricity would. Thus the cost of electricity to the establishment would be shown by entries such as the wages paid to employees at the generator and fuel costs in the case of thermal generators.[15]

In the census of manufacturing the items 'fuel and electricity' are extracted from total costs and displayed in a separate column. To quote the definitions used in these calculations:

> Figures for fuel refer to amounts actually used (including fuel used in cars, trucks, locomotives, etc.), not to purchases unless the quantities are substantially the same. Any fuel and electricity produced by establishments for internal consumption are not included in the total cost. Values represent laid-down cost at the establishment including freight, duty, etc. Although fuel and

> electricity used is considered part of manufacturing activity, it should be noted that it also includes relatively small amounts used in non-manufacturing activities since these cannot be reported separately.[16]

As these quotes indicate, both the I-O and the census of manufacturing tables provide figures for energy consumption which do not accurately represent the actual amount of energy consumed by the industries. They both fail to identify the consumption of energy generated within establishments. Such energy is known to be substantial in such industries as the primary metal and the pulp and paper industries.[17] The two sets of information, however, differ in their treatment of energy used as feedstocks. The I-O tables aggregate such energy commodities as coal, which is used for heating purposes and also as an input into the production of steel. Similar aggregations are involved with crude oil and natural gas. As a result, the exact amount spent on energy, as distinct from feedstocks, is not detectable directly from the tables. In contrast, the data drawn from the manufacturing sector exludes fuels used for non-fuel purposes. Nevertheless, there is information which can be used to adjust figures of energy consumption derived from the census of manufacturing data with that derived from the I-O tables. The next section explores the adjustments.

## A.4 Estimates of Energy Used in the Manufacturing Sector Compared: Census of Manufacturing Data Versus the Input-Output Estimates

Section A.3 has explored a number of important ways in which the estimates of energy consumption derived from the census of manufacturing sources differ from the I-O sources. If the two sets of data could be aligned it would provide the interpretation of the I-O tables with a useful piece of information. This usefulness is derived from the provincial breakdown of industrial energy use which is provided by the census of manufacturing data.

By relating this census of manufacturing data with the I-O data, an added regional dimension can be given to the analysis. In this way, heavy users of particular energy commodities can be specified by type of industry and by province.

The first step in the alignment of the two sets of data is to bridge the gap between the I-O data, which are measured in producers' prices and the census of manufacturing data which are measured in purchasers' prices. A means of performing this task is to estimate 'margins' for each energy commodity. These 'margins' include the retail, wholesale, tax and transportation margins which are added to producer prices and which add to the purchasers' price. Such estimates for the energy commodities for 1971 have been provided by the structural analysis branch of Statistics Canada. They are displayed in Table A.1.

A test of these estimates is to adjust the purchasers' price found in the census of manufacturing by those margins and in so doing form a set of producers' prices. These in turn can then be compared with the estimates of direct consumption of energy commodities as displayed in the I-O tables. Such an exercise has been undertaken, the results of which are shown in Table A.2.

On the whole, the adjustments provide a close set of figures. The one exception is the column headed LPG, and a collection of energy commodities described as 'Other Petroleum and Coal Products' in the M aggregation of the I-O tables. It would appear that the inclusion of coke in this latter aggregation and its exclusion from the group LPG is one of the major reasons for the divergence of the two estimates. As for the rest of the energy commodities, a distinction is made between a rounding error and those which are denoted as being 'significantly' different. It is the latter which are of interest. Three major reasons are forwarded as explanations of these differences: the inclusion of inventories in the census of manufacture estimates and their exclusion from the I-O estimates, the inclusion of energy feedstock estimates in the I-O estimates, and thirdly, the effects of the generation and consumption of energy by individual industries.

TABLE A.1

1971 COMMODITY MARGINS (ENERGY) NORMALIZED TO PURCHASERS' PRICE

| Commodity Number | Energy Commodities | Purchasers Price | Retail Margins | Wholesale Margins | Tax Margins | Transportation Margins | Gas Margins | Producers Price |
|---|---|---|---|---|---|---|---|---|
| 037 | Coal | 1.000000 | 0.002040 | 0.035343 | 0.000000 | 0.099284 | 0.000000 | 0.863333 |
| 038 | Crude Mineral Oils | 1.000000 | 0 | 0 | 0 | 0.100343 | 0 | 0.899657 |
| 039 | Natural Gas | 1.000000 | 0 | 0 | 0 | 0.254169 | 0.441476 | 0.304355 |
| 394 | Aviation Gasoline | 1.000000 | 0 | 0.096184 | 0.346214 | 0.038820 | 0 | 0.518782 |
| 395 | Motor Gasoline | 1.000000 | 0.089477 | 0.111612 | 0.405743 | 0.031396 | 0 | 0.361771 |
| 396 | Fuel Oil | 1.000000 | 0.009207 | 0.228993 | 0.161676 | 0.035717 | 0 | 0.564407 |
| 399 | Butane, Propane & Other Liquefied Pet. Gases | 1.000000 | 0 | 0.287575 | 0.022879 | 0.077948 | 0.015306 | 0.596291 |
| 546 | Electric Power | 1.000000 | 0 | 0 | 0.014153 | 0 | 0 | 0.985847 |
| 548 | Coke | 1.000000 | 0 | 0.042527 | 0 | 0.135138 | 0 | 0.822335 |

SOURCE: Provided by the Structural Analysis Branch, Statistics Canada.

TABLE A.2

FUEL AND ELECTRICITY USE IN CANADIAN MANUFACTURING INDUSTRIES:

CENSUS OF MANUFACTURING DATA COMPARED WITH ESTIMATES FROM I-O TABLES, 1971

(1971 $M at Producers' Prices)

| Industry/Commodity | Electricity | | Coal | | Natural Gas | | L.P.G.[3] | | Gasoline | | Fuel Oils | | Gasoline & Fuel Oil[5] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C.M.[4] | I-O | C.M.[4] | I-O | C.M.[4] | I-O | C.M.[4] | I-O | C.M.[4] | I-O | C.M.[4] | I-O | C.M.[4] | I-O |
| 1. Food & Beverage | 35.9 | (35.6)[1] | 1.0 | (0.8) | 5.2 | (4.7)[1] | 1.0 | (7.5) | 9.7 | | 14.1 | | 23.8 | (24.3)[1] |
| 2. Tobacco | 1.3 | (1.3) | - | (-) | 0.06 | (-)[2] | - | (0.1) | 0.1 | | 0.3 | | 0.4 | (0.4) |
| 3. Rubber | 9.9 | (9.9) | 0.1 | (0.1) | 0.6 | (0.4)[1] | 0.1 | (2.4) | 0.2 | | 2.3 | | 2.5 | (2.7)[1] |
| 4. Leather | 1.6 | (1.6) | 0.1 | (0.1) | 0.1 | (0.1) | - | (0.2) | - | | 0.5 | | 0.5 | (0.5) |
| 5. Textile | 13.0 | (13.0) | 0.1 | (0.1) | 0.9 | (0.8)[1] | 0.3 | (1.3) | 0.2 | | 4.6 | | 4.8 | (5.4)[1] |
| 6. Knitting | 1.8 | (1.8) | 0.1 | (0.1) | 0.1 | (0.1) | - | (-) | 0.02 | | 0.6 | | 0.62 | (0.7)[1] |
| 7. Clothing | 3.0 | (3.0) | - | (-) | 0.08 | (-)[2] | - | (0.2) | 0.2 | | 0.3 | | 0.5 | (0.5) |
| 8. Wood | 21.9 | (21.8)[2] | 0.1 | (0.1) | 1.1 | (1.0)[1] | 0.6 | (6.3) | 2.5 | | 4.3 | | 6.8 | (6.8) |
| 9. Furniture & Fixtures | 3.7 | (3.7)[1] | 0.2 | (0.2) | 0.3 | (0.2)[1] | - | (0.3) | 0.3 | | 0.6 | | 0.9 | (0.9) |
| 10. Paper & Allied Ind. | 115.8 | (117.3) | 8.5 | (8.4)[1] | 8.7 | (8.9)[1] | 0.6 | (15.8) | 0.6 | | 44.2 | | 44.8 | (56.8)[1] |
| 11. Printing, Publish. | 6.0 | (6.0) | - | (-) | 0.4 | (0.2)[1] | - | (0.9) | 0.5 | | 0.6 | | 1.1 | (1.1) |
| 12. Primary Metal | 89.2 | (86.4)[1] | 22.6 | (106.6)[1] | 9.1 | (8.6)[1] | 0.9 | (50.7) | 0.5 | | 18.5 | | 19.0 | (22.8)[1] |
| 13. Metal Fabricating | 17.2 | (17.1) | 0.2 | (0.2) | 2.8 | (2.2)[1] | 0.4 | (3.6) | 1.6 | | 2.6 | | 4.2 | (4.2) |
| 14. Machinery | 7.2 | (7.3)[2] | 0.2 | (0.2) | 1.1 | (1.0)[1] | 0.1 | (1.2) | 0.4 | | 1.0 | | 1.4 | (1.5)[1] |
| 15. Transportation Equipment | 23.4 | (23.2)[1] | 2.9 | (2.8)[1] | 2.5 | (2.5) | 0.2 | (6.9) | 0.9 | | 3.7 | | 4.6 | (5.1)[1] |
| 16. Electrical Prod. | 12.5 | (12.2)[1] | 0.2 | (0.2) | 1.2 | (0.8)[1] | 0.2 | (2.2) | 0.3 | | 1.6 | | 1.9 | (2.0)[1] |
| 17. Nonmetallic Mineral | 25.6 | (25.6) | 3.6 | (3.9)[1] | 7.3 | (7.2)[1] | 0.3 | (6.5) | 2.4 | | 11.9 | | 14.3 | (15.5)[1] |
| 18. Petroleum & Coal Products | 15.8 | (15.8) | - | (1.6)[1] | 1.3 | (1.3) | - | (17.1) | 0.1 | | 0.3 | | 0.4 | (0.4) |
| 19. Chemical & Chemical Products | 58.2 | (58.4)[1] | 1.3 | (2.7)[1] | 7.3 | (11.9)[1] | 1.0 | (103.1) | 0.8 | | 9.5 | | 10.3 | (13.5)[1] |
| 20. Misc. Manuf. | 5.5 | (5.1)[1] | 0.4 | (0.4) | 0.5 | (0.4)[1] | 0.1 | (1.5) | 0.5 | | 1.0 | | 1.5 | (1.5) |
| 21. All Manuf. Inds. | 468.5 | 466.1 | 41.6 | 128.5 | 50.6 | 52.3 | 5.9 | 227.8 | 21.7 | | 122.3 | | 144.0 | 166.6 |

SOURCES: Statistics Canada Catalogue No. 15-506E, Occasional [30], Table 86, pages 310-315; Statistics Canada Catalogue 57-506 [24].

NOTES:
[1]Denotes a significant difference.
[2]Denotes a rounding error.
[3]The estimates for L.P.G. (denoted as Other Petroleum and Fuel Oil in the 'M' Aggregation) all differ significantly in size. The I-O estimates include coke, and therefore they are not comparable.
[4]The census of manufacturing figures (C.M.) have been converted into producers prices by means of the conversion factor displayed in Table A.1. The figures from the C.M. sources are for purchased fuel and electricity while the I-O estimates are for used purchased fuel and electricity and feedstocks.
[5]These estimates for C.M. are a linear aggregation of the gasoline and fuel oil commodities.

The figures drawn from the census of manufacturing sources represent purchased fuel and electricity, while the I-O estimates are those of purchased fuel actually used. As a result, energy which is purchased but which is not used (i.e. inventories) swells the estimates made by census of manufacturing calculations. In contrast, the I-O figures include estimates of feedstocks which are used in the productive process. As feedstocks are not classified as 'heating', they are excluded from the census of manufacturing calculations. This latter distinction would seem to account for the large consumption of coal as registered by the I-O measures in the primary metal industries ($106.6 million) as against the estimated $22.6 million derived from the census of manufacturing estimates. (See Table A.2). Own generated and consumed energy does not show as commodity inputs in the I-O tables, but the labour and material costs incurred in producing the energy are recorded. As the last section indicated, any fuel or electricity produced by establishments for internal consumption are not included in the total costs in the census of manufacturing data. Such energy, however, generated and consumed by industrial establishments can be substantial. Electricity appears to be the most important energy form generated by industries. The breakdown of the source of electrical generating capacity suggests that industrial establishments accounted for 10 percent of Canada's electrical generating capacity in 1975. As Table A.3 shows, in 1975, industrial generation accounted for 26 percent of electrical capacity in British Columbia, 18 percent in Quebec, and 11 percent in New Brunswick. In view of the magnitude of these figures, it is of interest to discover the industries which account for most of the generation.

A detailed interprovincial examination of electricity generation revealed a list of the major industrial generators of electricity.[18] Details are displayed in Table A.4. This table defines large generators of electricity as those with a capacity of

TABLE A.3

PERCENTAGE OF TOTAL NATIONAL AND PROVINCIAL ELECTRICAL GENERATING CAPACITY OPERATED BY PUBLIC UTILITIES, PRIVATE UTILITIES, AND INDUSTRIAL ESTABLISHMENTS

DECEMBER 31, 1975

| | Publicly Operated Utilities (%) | Privately Operated Utilities (%) | Industrial Establishments (%) |
|---|---|---|---|
| Newfoundland | 13 | 86 | 1 |
| Prince Edward Island | 6 | 94 | - |
| Nova Scotia | 93 | - | 7 |
| New Brunswick | 88 | 2 | 11 |
| Quebec | 78 | 4 | 18 |
| Ontario | 94 | 1 | 4 |
| Manitoba | 99 | - | 1 |
| Saskatchewan | 92 | 6 | 2 |
| Alberta | 23 | 73 | 6 |
| British Columbia | 73 | 1 | 26 |
| Northwest Territories | 86 | 6 | 7 |
| Yukon | 84 | 8 | 7 |
| Canada | 75 | 16 | 10 |

SOURCE: S.C. Catalogue 57-206 [26], p. 17.

NOTE: Rows may not add to 100 owing to rounding.

TABLE A.4

LIST OF COMPANY PLANTS WITH TOTAL ELECTRICITY GENERATING CAPACITY OF 80,000 OR OVER BY TYPE, PROVINCE, COMPANY AND CAPACITY, 1975

| Type/Province/Company | Plant Name | Industrial Generating Capacity | | | Industry Title:L[h] |
|---|---|---|---|---|---|
| | | Capacity (KW) | % Cdn. Total[a] | % Prov. Total[a] | |
| 1. Hydro | | | | | |
| Quebec:[c] | | | | | |
| Aluminum Co. of Canada | Chute a Caron | 180,000 | 3.00 | 6.63 | |
| | Chute a la Savanne | 187,250 | 3.12 | 6.90 | |
| | Chute des Passes | 742,500 | 12.39 | 27.35 | 01300 |
| | Chute du Diable | 187,250 | 3.12 | 6.90 | 07800 |
| | Isle Maligne | 336,000 | 5.61 | 12.38 | 08000 |
| | Shipshaw | 717,000 | 11.96 | 26.41 | |
| | Total | 2,350,000 | 39.21 | 86.56 | |
| The Price Co. Ltd. | Adam Cunningham | 6,375 | 0.11 | 0.23 | |
| | Chicoutimi | 9,900 | 0.17 | 0.36 | |
| | Chute aux Galets | 13,600 | 0.23 | 0.50 | 05900 |
| | Jim Gray | 51,000 | 0.85 | 1.88 | 06400 |
| | Jonquiene Mill | 2,400 | 0.04 | 0.09 | 06900 |
| | Kenogami | 4,690 | 0.08 | 0.17 | |
| | Murdock Wilson | 51,000 | 0.85 | 1.88 | |
| | Total | 138,965 | 2.32 | 5.12 | |
| Ontario: | | | | | |
| Abitibi Paper Co. Ltd. | Iroquois Falls | 21,485 | 0.36 | 2.50 | 05900 |
| | Island Falls | 38,400 | 0.64 | 4.47 | 06400 |
| | Smooth Rock Falls | 6,250 | 0.10 | 0.73 | 06900 |
| | Twin Falls | 20,250 | 0.34 | 2.36 | |
| | Total | 86,385 | 1.44 | 10.05 | |
| British Columbia:[e] | | | | | |
| Alcan Smelters & Chemicals Ltd. | Kemano | 812,800 | 13.56 | 43.56 | 07800 12900 |
| | Total | 812,800 | 13.56 | 43.56 | |
| Cominco Ltd. | Brilliant | 108,800 | 1.82 | 5.83 | |
| | Coast Copper Benson L | 1,760 | 0.03 | 0.09 | |
| | Corna Linn | 40,500 | 0.68 | 2.17 | 01300 |
| | South Slocan | 47,250 | 0.79 | 2.53 | 07900 |
| | Upper Bannington | 55,125 | 0.92 | 2.95 | 12900 |
| | Waneta | 292,500 | 4.88 | 15.68 | |
| | Total | 545,935 | 9.11 | 29.26 | |
| MacMillan Bloedel Ltd. | Powell River | 17,080 | 0.28 | 0.92 | 06400 |
| | Stillwater | 28,800 | 0.48 | 1.54 | |
| | Total | 45,800 | 0.77 | 2.46 | |
| Northwest Territories:[f] | | | | | |
| Cominco Ltd. | Yellowknife | 3,360 | 0.60 | 34.08 | 01300 07900 12900 |
| | Total | 3,360 | 0.60 | 34.08 | |

...Cont'd.

TABLE A.4 (Cont'd)

| Type/Province/Company | Plant Name | Industrial Generating Capacity: Capacity (KW) | % Cdn. Total[a] | % Prov. Total[a] | Industry Title:[h] |
|---|---|---|---|---|---|
| 2. Steam | | | | | |
| Quebec: | | | | | |
| The Price Company Limited | Kenogami | 14,750 | 0.25 | 0.54 | 05900, 06400, 06900 |
| | Total | 14,750 | 0.25 | 0.54 | |
| British Columbia:[e] | | | | | |
| MacMillan Bloedel Ltd. | Canadian White Pine | 4,750 | 0.08 | 0.25 | |
| | Chemainus | 3,750 | 0.06 | 0.20 | |
| | Harmac | 36,750 | 0.61 | 1.97 | 06400 |
| | Port Alberni | 26,000 | 0.43 | 1.39 | 06900 |
| | Powell River | 50,925 | 0.85 | 2.73 | |
| | Total | 122,175 | 2.04 | 6.55 | |
| 3. Internal Combustion[f] | | | | | |
| Newfoundland: | | | | | |
| Aluminum Co. of Canada Limited | Power Plant | 2,283 | 0.04[b] | 2.71 | 01300, 07800, 08000 |
| | Total | 2,283 | 0.04 | 2.71 | |

SOURCE: S.C. Catalogue 57-206 Annual [26].

NOTES: [a]Percentage totals may not add exactly to the number given owing to rounding adjustments.

[b]These 6 companies: Aluminium Co. of Canada, The Price Company Ltd., Abitibi Paper Co. Ltd., Alcan Smelters & Chemicals Ltd., Cominco Ltd. and MacMillan Bloedel Ltd. account for 68.8 percent of total Canadian industrial generating capacity.

[c]The Aluminum Co. of Canada and The Price Company Ltd. account for 92.22 percent of total industrial generating capacity in Quebec.

[d]Abitibi Paper Co. Ltd. generates 10.05 percent of the industrially generated electricity in Ontario.

[e]Alcan Smelters & Chemicals Ltd., MacMillan Bloedel Ltd. and Cominco Ltd. account for 81.83 percent of industrial generating capacity in British Columbia.

[f]Aluminum Co. of Canada Ltd. generates 2.71 percent of the industrially generated electricity in Newfoundland.

[g]Cominco Ltd. accounts for 34.08 percent of the industrial generating capacity in Northwest Territories.

[h]

| No. | Industry Title | No. | Industry Title |
|---|---|---|---|
| 01300 | Other Non-Metal Mines | 07800 | Aluminum Smelting & Refining |
| 05900 | Sawmills | 07900 | Other Smelting & Refining |
| 06400 | Misc. Wood Industries | 08000 | Aluminum Rolling & Extruding |
| 06900 | Pulp & Paper Industry | 12900 | Mfgrs. of Industrial Chemicals |

over 80,000 kW. Details of the company and plant site are provided, and from this information the type of industry using such energy is specified.

The table shows that in 1975 six companies accounted for almost 70 percent of the total Canadian industrial generating capacity. When broken down into the industrial classification used in the L aggregation of the I-O table, eight industries accounted for this generation of electricity. Three of the eight were the sawmills, pulp and paper industry and miscellaneous wood industries. Another three were under the group 'Primary Metal Industries' of the M aggregation and include the industries aluminum smelting and refining, other smelting and refining, and aluminum rolling and extending. The two remaining industries making up the eight were the manufacturers of industrial chemicals and other non-metal mines. In view of the exclusion of own generated electricity in the I-O table, this enquiry suggests that the consumption of electricity is likely to be considerably underestimated[19] in the Quebec and B.C. aluminum and pulp and paper industries.

A further insight into the distortion that could be caused by the industrial generation and consumption of electricity is provided by the 'Btu input-output tables'. These tables measure energy commodities in terms of their Btu equivalences. Of particular interest is their treatment of industrial generation and consumption of electricity. In the tables produced by Statistics Canada, such energy is calculated separately so that its relative importance in particular industries can be assessed.[20] Table A.5 presents Btu measures of this industrially generated electricity, divided into thermal and hydro electricity. The table shows that in 1971 hydro accounted for 81 percent of the generated electricity. The largest shows were in the primary metal industries (which accounted for over 65 percent of the total industrial electricity), the paper and allied industries (with over 22 percent), and the chemical and chemical products industries (6 percent). It will be recalled that these same three industries were highlighted earlier as being the big producers of industrial electricty.

TABLE A.5

AMOUNT OF INDUSTRY GENERATED ELECTRICITY IN 1971:
I-O TABLES USING BTU MEASURES

| Industry | Industry Generated Hydro | | Industry Generated Thermal | | Total Industry Generated Electricity | |
|---|---|---|---|---|---|---|
| | BTU (M)[a] | % of Total[b] | BTU (M) | % of Total | BTU (M) | % of Total |
| Forestry | 9,523 | 0.0001 | 20,472 | 0.0012 | 29,995 | 0.0003 |
| Metal Mines | 617,551 | | 881,521 | 0.0544 | 1,499,072 | 0.0176 |
| Mineral Fuels | - | | 1,115,287 | 0.0688 | 1,115,287 | 0.0131 |
| Non-Metal Mines & Quarries | - | | 554,658 | 0.0342 | 554,658 | 0.0065 |
| Food & Bev. Inds. | - | | 313,430 | 0.0193 | 313,430 | 0.0037 |
| Rubber & Plastic Prods. Inds. | - | | 21,653 | 0.0013 | 21,653 | 0.0002 |
| Textile Inds. | 46,608 | | 243,262 | 0.0150 | 289,870 | 0.0034 |
| Knitting Mills | - | | 5,207 | 0.0003 | 5,207 | 0.0001 |
| Wood Inds. | 9,270 | 0.0001 | 852,584 | 0.0526 | 861,854 | 0.0101 |
| Paper & Allied Inds. | 13,454,050 | 0.1956 | 5,326,656 | 0.3287 | 18,780,706 | 0.2210 |
| Primary Metal Inds. | 54,367,584 | 0.7906 | 1,047,303 | 0.0646 | 55,414,887 | 0.6522 |
| Transport Equip. Inds. | - | | 244,013 | 0.0150 | 244,013 | 0.0028 |
| Elect. Prod. Inds. | - | | 5,579 | 0.0003 | 5,579 | 0.0001 |
| Pet. & Coal Prod. Inds. | - | | 198,619 | 0.0122 | 198,619 | 0.0023 |
| Chemical & Chemical Prod. Inds. | 235,466 | 0.0034 | 5,372,268 | 0.3315 | 5,607,734 | 0.0660 |
| Transportation & Storage | 5,415 | - | - | - | 5,415 | 0.0001 |
| Education & Health Services | 15,525 | 0.0002 | - | - | 15,525 | 0.0002 |
| Total | 68,760,992 | 1.0000 | 16,202,512 | 1.0000 | 84,963,504 | 1.0000 |

SOURCE: Provided by the Structural Analysis Branch, Statistics Canada.

NOTES: [a]A description of the calculation of BTU equivalences can be obtained in Appendix B.
[b]Totals may not add exactly to 1.000 due to rounding.

While some of these figures appear large, the point to be observed is how large are they relative to the other direct energy commodities which are used and which appear in the I-O tables? Table A.6 explores this question by relating the industrially generated electricity to the total output of each industry which produces its own electricity. These direct coefficients are then compared with the direct coefficients for all the energy commodities. As Table A.6 shows for 1971, only in the primary metal industries does the own generated electricity appear large. It represents 13 percent of the total direct energy coefficient. These figures suggest that in the I-O tables the exclusion of own generated electricity is only likely to have a significant effect in the primary metal industries. It would appear that the direct energy coefficient derived from the I-O tables will reveal lower energy intensities per output in this industry than in fact is the case. Before comprehending the full effects of this deficiency, a number of qualifying points need to be made. The first point is that although the industrially generated and consumed electricity is not included directly in the inputs, the cost of labour and raw materials appear in the inputs. In those plants using thermal electricity, coal will apppear in the input rows. The information provided in Table A.6 suggests that less than 2 percent of the own generated electricity is derived from thermal plants. The result is that energy will not appear in the I-O tables in the 'form' of coal, and so the energy intensity in this industry will be considerably underestimated. The second point is that some of these industries not only produce and consume their own electricity, they also sell it to other users. As Table A.7 shows, the latter has fallen as a share of the output of electricity from 3 to 2 percent between 1966 and 1971. This reflects a broader trend, which is that not only are industries selling less of their own generated electricity, but they are purchasing a larger share from the electricity utilities.[21] The effect of this in the I-O

TABLE A.6

COMPARISONS OF THE DIRECT ENERGY COEFFICIENTS OF OWN GENERATED ELECTRICITY WITH THE TOTAL ENERGY COEFFICIENTS: 1971

(Output Measured in 1961 Prices)

| | $ Million Output 1961 Prices | BTUs per Dollar of Output | | | | Ratio of Own Generated Electricity To Total Energy BTU per Dollar Output | | |
|---|---|---|---|---|---|---|---|---|
| | | Hydro | Thermal | Total | Total All Energy Input | Hydro | Thermal | Total |
| Forestry | 918.1 | 10.3 | 22.3 | 32.6 | 39,964.5 | 0.0002 | 0.0005 | 0.0008 |
| Metal Mines | 1,591.4 | 388.0 | 553.9 | 941.9 | 51,217.6 | 0.0108 | 0.0183 | 0.0183 |
| Mineral Fuels | 1,722.2 | - | 647.6 | 647.6 | 77,339.1 | - | 0.0083 | 0.0083 |
| Non Metal Mines & Quarries | 530.3 | - | 1,045.9 | 1,045.9 | 72,906.9 | - | 0.0143 | 0.0143 |
| Food & Bev. Inds. | 7,528.2 | - | 41.6 | 41.6 | 12,730.3 | - | 0.0032 | 0.0032 |
| Rubber & Plastic Prod. Inds. | 1,169.9 | - | 18.5 | 18.5 | 6,545.8 | - | 0.0028 | 0.0028 |
| Textile Inds. | 1,708.2 | 27.2 | 142.4 | 169.6 | 16,696.8 | 0.0016 | 0.0085 | 0.0101 |
| Knitting Mills | 430.4 | - | 12.0 | 12.0 | 6,698.8 | - | 0.0017 | 0.0017 |
| Wood Inds. | 1,625.9 | 5.7 | 524.3 | 530.0 | 16,321.0 | 0.0003 | 0.0321 | 0.0324 |
| Paper & Allied Inds. | 3,440.6 | 3,910.3 | 1,548.1 | 5,458.4 | 96,022.4 | 0.0407 | 0.0161 | 0.0568 |
| Primary Metal Inds. | 4,085.5 | 13,307.4 | 256.3 | 13,563.7 | 100,311.7 | 0.1326 | 0.0025 | 0.1352 |
| Transport Equip. Inds. | 6,290.5 | - | 38.8 | 126.0 | 4,575.7 | - | 0.0084 | 0.0275 |
| Electrical Prod. Inds. | 2,597.2 | - | 2.1 | 2.1 | 5,660.0 | - | 0.0003 | 0.0003 |
| Pet. & Coal Prod. Inds. | 1,935.2 | - | 102.6 | 102.6 | 18,050.5 | - | 0.0056 | 0.0056 |
| Chemical & Chemical Prod. Inds. | 2,698.9 | 87.2 | 1,990.5 | 2,077.7 | 78,234.7 | 0.0011 | 0.0254 | 0.0265 |
| Transportation & Storage | 6,623.3 | 0.8 | - | 0.8 | 70,812.4 | - | - | - |
| Education & Health Services | 1,273.3 | 12.2 | - | 12.2 | 11,702.6 | 0.0010 | - | 0.0010 |

SOURCE: The BTU estimates were provided by the Structural Analysis Branch, Statistics Canada. The output measures were taken from Table 65 in S.C. Cat. 15-507E [29].

TABLE A.7

PRODUCTION OF ELECTRICITY BY INDUSTRIES: 1966 AND 1971

TAKEN FROM THE I-O TABLES

($ million, 1961 prices)

| Industry | Electricity Produced[b] ($ million, 1961 prices) 1966 | % | 1971 | % |
|---|---|---|---|---|
| Forestry | 0.1) | | 0.1) | |
| Metal Mines | 1.1) | | 0.9) | |
| Non-Metal Mines & Quarries | 0.1) | | - ) | |
| Wood | 0.1) | | 0.3) | |
| Paper & Allied Industries | 3.6) | 0.03 | 3.5) | 0.02 |
| Primary Metal Industries | 13.6) | | 10.2) | |
| Transport Equip. Industries | 0.3) | | -) | |
| Transport & Storage | 8.5) | | 7.1) | |
| Electric Power, Gas & Other Utilities | 1230.1 | 0.97 | 1583.0 | 0.98 |
| Total 1.00 | 1257.7[a] | 1.00 | 1605.3 | |

SOURCE: S.C. Catalogue 15-507E Occasional [29], Tables 34 and 64.

NOTES: [a]Totals may not add due to rounding and suppression of confidential commodities.

[b]Only that electricity which is produced and sold is recorded as 'production' in the I-O tables.

tables is that it would appear that such industries are growing more energy intensive, when in fact what is happening is that they are now purchasing electricity from the utilities and supplementing their own generated supplies. The latter is excluded in the tables, while the former is included, with the result that it would appear that there is a large growth in the consumption of electricity. This last point will be explored a little further in Appendix B.

## A.5 Energy Consumption by the Manufacturing Industries

The last section displayed the measures of producers' and purchasers' prices used in the I-O and the census of manufacturing data. Now that these differences have been located, we feel free to proceed to use the census of manufacturing data as a means of indicating, in more detail, the use of energy commodities on a more disaggregated level by industry and by province. It will be recalled that such detail is provided for the list of manufacturing industries, the latest data being available for 1975. The object is to use this data to identify the larger energy consumers by industry and by province and to use this information to interpret the results derived from the I-O tables.

Table A.8 presents the census of manufacturing data in a form which shows the proportion of each energy commodity bought by the twenty manufacturing-industries in 1971 and 1975. Note the large share accounted for by the paper and allied industries, the primary metal industries and the chemical and chemical product industries. In Table A.9 the same set of manufacturing industries are observed, but this time the consumption of energy is derived from the I-O table for 1971. In comparing the two tables, note should be made of the points made earlier in this appendix. It will be recalled that energy feedstocks are included in the I-O estimates, but not so in the census of manufacturing data. Note

TABLE A.8

CONSUMPTION OF PURCHASED FUEL & ELECTRICITY BY THE MANUFACTURING INDUSTRIES OF CANADA: PERCENTAGE USE ($) BY INDUSTRIES OF SELECTED ENERGY COMMODITIES: 1971 AND 1975

| Industry/Commodity | Electricity | | Coal | | Natural Gas | | Gasoline & Fuel Oil | | All Energy Commodities[a] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1971 | 1975 | 1971 | 1975 | 1971 | 1975 | 1971 | 1975 | 1971 | 1975 |
| 1. Food & Beverage | 7.6 | 8.2 | 2.3 | 0.7 | 10.3 | 10.3 | 15.0 | 18.7 | 10.9 | 10.7 |
| 2. Tobacco Prod. Inds. | 0.2 | 0.2 | - | - | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 |
| 3. Rubber & Plastic Prod. Inds. | 2.1 | 2.5 | 0.1 | - | 1.1 | 1.6 | 1.4 | 1.6 | 1.7 | 1.9 |
| 4. Leather Inds. | 0.3 | 0.3 | 0.1 | - | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 |
| 5. Textile Inds. | 2.8 | 2.8 | 0.2 | - | 1.7 | 2.0 | 3.4 | 3.1 | 2.6 | 2.8 |
| 6. Knitting Mills | 0.9 | 0.4 | 0.1 | - | 0.2 | 0.2 | 0.4 | 0.4 | 0.3 | 0.3 |
| 7. Clothing Inds. | 0.6 | 0.6 | - | - | 0.1 | 0.1 | 0.4 | 0.3 | 0.4 | 0.4 |
| 8. Wood Inds. | 4.7 | 5.4 | 0.2 | 0.2 | 2.2 | 2.1 | 4.6 | 5.2 | 4.3 | 4.3 |
| 9. Furniture Inds. | 0.8 | 0.8 | 0.5 | - | 0.6 | 0.5 | 1.1 | 0.7 | 0.7 | 0.6 |
| 10. Paper & Allied Inds. | 24.7 | 22.4 | 20.5 | 25.0 | 17.0 | 14.1 | 30.9 | 28.8 | 24.3 | 23.1 |
| 11. Printing, Pub. & Allied Inds. | 1.3 | 1.3 | - | - | 0.7 | 0.5 | 0.7 | 0.9 | 1.0 | 0.9 |
| 12. Primary Metal Inds. | 19.0 | 18.8 | 54.2 | 50.3 | 18.0 | 19.5 | 12.3 | 12.4 | 18.3 | 17.6 |
| 13. Metal Fab. Inds. | 3.7 | 3.6 | 0.4 | - | 5.6 | 4.5 | 2.9 | 3.2 | 3.6 | 3.4 |
| 14. Machinery Inds. | 1.5 | 1.8 | 0.5 | 0.2 | 2.2 | 1.8 | 1.0 | 1.0 | 1.4 | 1.5 |
| 15. Transp. Equip. Inds. | 4.5 | 5.4 | 7.0 | 4.4 | 5.0 | 4.2 | 3.6 | 3.2 | 4.6 | 4.4 |
| 16. Elect. Prod. Inds. | 2.7 | 2.7 | 0.5 | 0.9 | 2.2 | 1.9 | 1.0 | 1.3 | 2.1 | 2.0 |
| 17. Non-Metallic Min. Prod. Inds. | 5.4 | 6.0 | 8.8 | 17.8 | 14.5 | 13.8 | 11.4 | 9.9 | 8.3 | 9.6 |
| 18. Pet. & Coal Prod. Inds. | 3.4 | 4.0 | - | - | 2.6 | 4.5 | 0.3 | 0.2 | 2.1 | 2.7 |
| 19. Chemical & Chem. Prod. | 12.4 | 11.0 | 3.2 | - | 14.3 | 16.8 | 8.8 | 6.9 | 11.2 | 12.0 |
| 20. Misc. Manuf. Inds. | 1.2 | 1.2 | 0.8 | - | 1.0 | 0.7 | 0.7 | 1.2 | 1.1 | 0.8 |
| Totals[b] | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

SOURCES: Statistics Canada Catalogue No. 57-208, Annual [23] 1975, Table 5, page 14.
Statistics Canada Catalogue No. 57-506, Occasional [24] 1977.

NOTES: [a]All energy includes not only the above energy commodities, but also L.P.G., heavy fuel oil and other energy products.
[b]The totals do not add to exactly 100.0 owing to rounding.

TABLE A.9

THE CONSUMPTION OF PURCHASED ENERGY BY THE MANUFACTURING INDUSTRIES OF CANADA AS REGISTERED BY THE I-O TABLES: PERCENTAGE USE BY INDUSTRY OF THE TOTAL DIRECT USE BY ALL USERS OF ENERGY. 1971

| Industry/Commodity | Electricity | Coal | Natural Gas | Gasoline & Fuel Oil |
|---|---|---|---|---|
| 1. Food & Beverage | 3.7 | 0.3 | 5.0 | 2.5 |
| 2. Tobacco Prod. Inds. | 0.1 | - | - | - |
| 3. Rubber & Plastic Prod. | 1.0 | - | 0.4 | 0.9 |
| 4. Leather Inds. | 0.1 | - | 0.1 | - |
| 5. Textile Inds. | 1.3 | - | 0.8 | 1.6 |
| 6. Knitting Mills | 0.2 | - | 0.1 | - |
| 7. Clothing Inds. | 0.3 | - | - | - |
| 8. Wood Inds. | 2.2 | - | 1.0 | 0.7 |
| 9. Furniture Inds. | 0.4 | - | 0.2 | - |
| 10. Paper & Allied Inds. | 12.1 | 3.4 | 9.0 | 14.0 |
| 11. Printing, Publishing & Allied Inds. | 0.6 | - | 0.2 | 0.1 |
| 12. Primary Metal Inds. | 9.0 | 43.3 | 8.6 | 2.4 |
| 13. Metal Fabricating Inds. | 1.8 | - | 2.2 | 0.4 |
| 14. Machinery Inds. | 0.7 | - | 1.0 | 0.1 |
| 15. Transport Equip. Inds. | 2.4 | 0.1 | 2.5 | 0.6 |
| 16. Elect. Prod. Inds. | 1.2 | - | 0.8 | 0.2 |
| 17. Non-Metallic Mineral Products Inds. | 2.6 | 1.6 | 7.2 | 1.6 |
| 18. Pet. & Coal Prod. Inds. | 1.6 | 0.6 | 1.3 | - |
| 19. Chemical & Chemical Prod. Inds. | 6.0 | 1.1 | 12.0 | 1.4 |
| 20. Misc. Manuf. Inds. | 0.5 | 0.1 | 0.4 | 0.1 |
| All Industries | 49.4 | 50.6 | 52.8 | 26.6 |
| All Industry Consumption as a Percentage of Total Usage[a] | 23.0 | 37.0 | 16.1 | 8.3 |

SOURCE: S.C. Cat. 15-506E Occasional [30], Table 86, pages 310-315.

NOTES: [a]Total usage figures taken from Table 2.4, the penultimate column.

the last row of Table A.9, which displays the percentage of energy consumed by the manufacturing industries of the total direct use of the energy commodities in 1971. The percentages accounted for by the manufacturing demand for electricity (23 percent) and the manufacturing demand for coal (37 percent) are high, but lower for natural gas and gasoline and fuel oil. Both tables indicate the importance of four manufacturing industries as large consumers of energy: primary metal industries (coal and electricity), paper and allied industries (natural gas, electricity and gasoline and fuel oil), the chemical and chemical product industries (electricity and natural gas) and non-metallic mineral producing industries (natural gas). Table A.10 takes the 1975 census of manufacturing data and examines the detailed consumption of these energy commodities by each industry within the above four industrial manufacturing aggregations. From this analysis, seven industries are shown to be the major industrial consumers of energy: iron and steel mills, smelting and refining industries, pulp and paper mills, cement manufacturers, glass and glass product manufacturers, industrial chemicals (inorganic) NES and industrial chemicals (organic) NES.

Table A.11 takes these seven industries and examines their consumption of energy by province. The percentages relate to the Canadian total for 1975. Using the table, it can be seen that 100 percent of the coal and coke consumed in the iron and steel mills was consumed by the mills in Ontario. Indeed, the table highlights the predominance of industry in central Canada (Ontario and Quebec). Only in the consumption of natural gas and electricity in the production of industrial chemicals did the prairie provinces make a significant showing, while B.C. registered its importance in the consumption of gasoline and fuel oil, and electricity by that province's pulp and paper mills.

TABLE A.10

VALUE OF ENERGY CONSUMED IN SELECTED CANADIAN INDUSTRIES
$ million (current) 1975

| Industry | Coal & Coke | | Natural Gas | | Gasoline & Fuel Oil | | Electricity | |
|---|---|---|---|---|---|---|---|---|
| | $ | % | $ | % | $ | % | $ | % |
| **Primary Metal Industries** | | | | | | | | |
| Iron & Steel Mills | 100 | 0.4 | 48,815 | 66.6 | 733 | 38.1 | 57,220 | 46.5 |
| Steel Pipe & Tube Mills | - | - | 2,552 | 3.5 | 155 | 8.1 | 4,515 | 3.7 |
| Iron Foundries | 745 | 2.9 | 2,186 | 3.0 | 265 | 13.8 | 6,486 | 5.2 |
| Smelting & Refining | 25,061 | 96.7 | 19,776 | 27.0 | 772 | 40.1 | 54,830 | 44.5 |
| | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| **Paper & Allied Industries** | | | | | | | | |
| Pulp & Paper Mills | 51,614 | 89.2 | | | 174,327 | 97.2 | 145,868 | 91.6 |
| Paper Box & Bag Manufacturers | 2,242 | 3.9 | | | 1,804 | 1.0 | 5,123 | 3.2 |
| Folding Cartons & Set-up Boxes Mfrs. | 413 | 0.7 | | | 351 | 0.2 | 1,083 | 0.7 |
| Corrugated Box Manufacturers | 1,376 | 2.4 | | | 1,206 | 0.7 | 2,044 | 1.3 |
| Paper & Plastic Bag Mfrs. | 452 | 0.8 | | | 247 | 0.1 | 1,995 | 1.3 |
| Misc. Paper Converters | 1,782 | 3.1 | | | 1,453 | 0.8 | 3,213 | 2.0 |
| | | 100.0 | | | | 100.0 | | 100.0 |
| **Non-Metallic Mineral Producing Inds.** | | | | | | | | |
| Clay Product Mfrs. | 33 | 0.3 | 6,040 | 7.8 | 2,957 | 3.2 | 2,176 | 4.1 |
| Cement Manufacturers | 6,106 | 58.4 | 19,521 | 25.1 | 33,100 | 36.8 | 14,350 | 27.0 |
| Stone Products Mfrs. | - | - | 28 | - | 284 | 0.3 | 254 | 0.4 |
| Concrete Products Mfrs. | - | - | 2,080 | 2.7 | 17,016 | 19.0 | 2,183 | 4.0 |
| Concrete Pipe Mfrs. | - | - | 432 | - | 2,006 | 2.2 | 682 | 1.2 |
| Mfrs. Structural Concrete Prod. | - | - | 291 | 0.4 | 987 | 1.1 | 352 | 0.6 |
| Concrete Products Mfrs. NES | - | - | 1,356 | 1.7 | 3,626 | 4.0 | 1,149 | 2.1 |
| Ready-mix Concrete Mfrs. | 5 | - | 715 | 0.9 | 13,365 | 14.8 | 2,147 | 4.0 |
| Glass & Glass Products Mfrs. | - | - | 14,414 | 18.5 | 1,541 | 1.7 | 5,362 | 10.0 |
| Glass Manufactuers | - | - | 13,288 | 17.1 | 1,879 | 2.1 | 4,105 | 7.7 |
| Glass Products Mfrs. | - | - | 1,126 | 1.5 | 1,345 | 1.5 | 1,257 | 2.3 |
| Abrasives Manufacturers | - | - | 369 | 0.5 | 208 | 0.2 | 9,355 | 17.5 |
| Lime Manufacturers | 1,914 | 18.3 | 5,536 | 7.1 | 3,652 | 4.0 | 964 | 1.8 |
| Misc. Non-metallic Mineral Prods. | 1,197 | 11.4 | 6,309 | 8.1 | 5,072 | 5.6 | 4,468 | 8.3 |
| Refractories Mfrs. | 98 | 0.9 | 353 | 0.5 | 2,264 | 2.5 | 427 | 0.8 |
| Misc. Non-metallic Mineral Prods. NES | 1,099 | 10.5 | 5,956 | 7.7 | 485 | 0.5 | 4,041 | 7.5 |
| | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| **Chemical & Chemical Products Inds.** | | | | | | | | |
| Mfrs. of Mixed Fertilizers | | | 43 | - | | | 329 | 0.2 |
| Mfrs. of Plastics & Synthetic Resins | | | 5,245 | 4.2 | | | 5,245 | 3.7 |
| Mfrs. of Pharmaceuticals & Medicines | | | 1,116 | 0.9 | | | 2,253 | 1.6 |
| Paint & Varnish Mfrs. | | | 477 | 0.4 | | | 1,218 | 0.9 |
| Mfrs. of Soap & Cleaning Compounds | | | 1,143 | 0.9 | | | 1.328 | 0.9 |
| Mfrs. of Toilet Preparations | | | 245 | 0.2 | | | 551 | 0.4 |
| Mfrs. of Industrial Chemicals | | | 56,534 | 45.1 | 35,315 | 37.6 | 60,818 | 43.2 |
| Mfrs. of Pigments & Dry Colour | | | 1,682 | 1.3 | | | 1,865 | 1.3 |
| Industrial Chem. (inorganic) NES | | | 17,370 | 13.9 | 17,336 | 18.4 | 42,633 | 30.3 |
| Industrial Chem. (organic) NES | | | 37,482 | 29.9 | 16,796 | 17.8 | 16,320 | 11.6 |
| Misc. Chemical Industries | | | 2,036 | 1.6 | | | 4,127 | 2.9 |
| Mfrs. of Printing Inks | | | 132 | 0.1 | | | 340 | 0.2 |
| Misc. Checmical Inds. NES | | | 1,903 | 1.5 | | | 3,787 | 2.7 |
| | | | | 100.0 | | | | 100.0 |

SOURCE: S.C. Catalogue 57-208 [23], Table 5, pp. 14-21.

NOTES: Percentages may not total to exactly 100.0 owing to rounding.
The 'Gasoline & Fuel Oil' category consists of the gasoline, kerosene, diesel oil, light fuel oil and heavy fuel oil categories from Statistics Canada.

TABLE A.11

VALUE OF ENERGY CONSUMED BY SELECTED INDUSTRIES: PROVINCIAL BREAK-DOWN
(current $ million 1975)

| Inds. No. | Industry/Province[a] | B.C. | Alta. | Sask. | Man. | Ont. | Que. | N.B. | N.S. | Nfld. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **COAL AND COKE** | | | | | | | | | | | |
| **Primary Metal Industry** | | | | | | | | | | | |
| 2910 | Iron & Steel Mills: | | | | | | | | | | |
| | Value | - | - | - | - | 21 | - | - | - | - | 21 |
| | % of Canadian Total[b] | - | - | - | - | 100.00 | - | - | - | - | 100.00 |
| 2950 | Smelting & Refining: | | | | | | | | | | |
| | Value | - | - | - | - | 7,270 | 16,186 | - | - | - | 23,456 |
| | % of Canadian Total[b] | - | - | - | - | 30.99 | 69.01 | - | - | - | 100.00 |
| **Paper & Allied Industries** | | | | | | | | | | | |
| 2710 | Pulp & Paper Mills: | | | | | | | | | | |
| | Value | - | - | - | - | 6,393 | 5,500 | - | - | - | 11,893 |
| | % of Canadian Total[b] | - | - | - | - | 53.75 | 46.25 | - | - | - | 100.00 |
| **NATURAL GAS** | | | | | | | | | | | |
| **Primary Metal Industry** | | | | | | | | | | | |
| 2910 | Iron & Steel Mills: | | | | | | | | | | |
| | Value | - | - | - | - | 34,430 | 13,077 | - | - | - | 47,507 |
| | % of Canadian Total[b] | - | - | - | - | 72.47 | 27.53 | - | - | - | 100.00 |
| 2950 | Smelting & Refining: | | | | | | | | | | |
| | Value | - | - | - | - | 12,470 | 3,529 | - | - | - | 15,999 |
| | % of Canadian Total[b] | - | - | - | - | 77.94 | 22.06 | - | - | - | 100.00 |
| **Non-Metallic Min. Prod. Inds.** | | | | | | | | | | | |
| 3520 | Cement Mfrs.: | | | | | | | | | | |
| | Value | - | - | - | - | 8,249 | 3,851 | - | - | - | 12,100 |
| | % of Canadian Total[b] | - | - | - | - | 68.17 | 31.83 | - | - | - | 100.00 |
| 3560 | Glass & Glass Prod. Mfrs.: | | | | | | | | | | |
| | Value | - | - | - | - | 10,089 | 3,690 | - | - | - | 13,779 |
| | % of Canadian Total[b] | - | - | - | - | 73.22 | 26.78 | - | - | - | 100.00 |
| 3561 | Glass Mfrs.: | | | | | | | | | | |
| | Value | - | - | - | - | 9,093 | - | - | - | - | 9,093 |
| | % of Canadian Total[b] | - | - | - | - | 100.00 | - | - | - | - | 100.00 |
| **Chemicals & Chem. Prod. Inds.** | | | | | | | | | | | |
| 3780 | Mfrs. of Ind. Chem.: | | | | | | | | | | |
| | Value | 1,814 | 8,898 | 173 | - | 43,188 | 1,203 | - | - | - | 55,276 |
| | % of Canadian Total[b] | 3.28 | 16.10 | 0.31 | - | 78.13 | 2.18 | - | - | - | 100.00 |
| 3782 | Ind. Chem. (inorganic)NES | | | | | | | | | | |
| | Value | - | - | - | 1,258 | 8,603 | 28 | - | - | - | 9,889 |
| | % of Canadian Total[b] | - | - | - | 12.72 | 86.996 | 0.28 | - | - | - | 100.00 |
| 3783 | Ind. Chem. (organic)NES | | | | | | | | | | |
| | Value | - | 2,914 | - | - | 33,818 | - | - | - | - | 36,738 |
| | % of Canadian Total[b] | - | 7.93 | - | - | 92.06 | - | - | - | - | 100.00 |

....Cont'd.

TABLE A.11 (Cont'd)

| Inds. No. | Industry/Province | B.C. | Alta. | Sask. | Man. | Ont. | Que. | N.B. | N.S. | Nfld. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GASOLINE & FUEL OIL:[c]** | | | | | | | | | | | |
| **Primary Metal Industry** | | | | | | | | | | | |
| 2910 | Iron & Steel Mills: | | | | | | | | | | |
| | Value | - | - | - | - | 17,440 | 2,274 | - | - | - | 19,714 |
| | % of Canadian Total[b] | - | - | - | - | 88.47 | 11.53 | - | - | - | 100.00 |
| 2950 | Smelting & Refining: | | | | | | | | | | |
| | Value | - | - | - | - | 10,838 | 21,817 | - | - | - | 32,655 |
| | % of Canadian Total[b] | - | - | - | - | 33.19 | 66.81 | - | - | - | 100.00 |
| **Paper & Allied Industries** | | | | | | | | | | | |
| 2710 | Pulp & Paper Mills: | | | | | | | | | | |
| | Value | 42,473 | 331 | - | - | 12,790 | 70,893 | 29,302 | 8,984 | 7,357 | 172,130 |
| | % of Canadian Total[b] | 24.67 | 0.19 | - | - | 7.43 | 41.19 | 17.02 | 5.22 | 4.27 | 100.00 |
| **ELECTRICITY** | | | | | | | | | | | |
| **Paper & Allied Industries** | | | | | | | | | | | |
| 2710 | Pulp & Paper Mills: | | | | | | | | | | |
| | Value | 21,228 | 594 | - | - | 32,483 | 58,405 | 19,703 | 4,134 | 5,821 | 142,368 |
| | % of Canadian Total[b] | 14.51 | 0.42 | - | - | 22.82 | 41.02 | 13.84 | 2.90 | 4.09 | 100.00 |
| **Chemicals & Chem. Prod. Ind.** | | | | | | | | | | | |
| 3780 | Mfrs. of Ind. Chem.: | | | | | | | | | | |
| | Value | 6,115 | 5,538 | 590 | - | 30,835 | 10,224 | 1,413 | 3,478 | - | 58,193 |
| | % of Canadian Total[b] | 10.51 | 9.52 | 1.01 | - | 52.99 | 17.57 | 2.43 | 5.98 | - | 100.00 |
| 3782 | Ind. Chem. (inorganic)NES | | | | | | | | | | |
| | Value | - | - | - | 1,501 | 19,637 | 7,417 | 1,413 | - | - | 29,968 |
| | % of Canadian Total[b] | - | - | - | 5.01 | 65.53 | 24.75 | 4.72 | - | - | 100.00 |
| 3783 | Ind. Chem. (organic) NES: | | | | | | | | | | |
| | Value | - | 2,682 | - | - | 10,706 | - | - | - | - | 13,388 |
| | % of Canadian Total[b] | - | 20.03 | - | - | 79.97 | - | - | - | - | 100.00 |

SOURCE: S.C., Catalogue 57-208, [23] Tables 6 through 15, pp. 22-53.

NOTES: [a]Prince Edward Island is not included because its shares were statistically insignificant.
[b]Percentages may not total 100.00 owing to rounding.
[c]The "Gasoline & Fuel Oil" category consists of the gasoline, kerosene, diesel oil, light fuel oil and heavy fuel oil categories from Statistics Canada.

## FOOTNOTES - APPENDIX A

[1]See: National Income and Expenditure Accounts [31], Chapter 3.

[2]In order to simplify the exposition, the industries are assumed to produce only one commodity. There are no taxes or subsidies existing in the economy.

[3]'Net' of subsidies.

[4]Statistics Canada Catalogue 15-506E [30], page 13.

[5]Statistics Canada Catalogue 15-506E [30], Chapter 4, pp. 27-28.

[6] See UN [51], Chapter 4, especially the Annex, pp. 66-67.

[7]An example of the distorting effects of taxation and the difficulties resulting from aggregating similar, but differently taxed commodities, is shown in the group of commodities known as petroleum products. If gasoline and fuel oil are included in this group, and if the rate of tax is low on the latter and high on the former, then a dollar's worth of petroleum products at prices inclusive of taxes will represent a much smaller quantity for road transport companies and private motorists than it will for fuel oil using industries.

[8]For example, in the case of multi-establishment companies, the several establishments are classified to different industries, while in contrast, according to the company classification, all the activity is classified to one industry.

[9]For a discussion of this point, and the points of distinction between I-O tables and National Accounts on such items as exports and imports, see I-O Structure, Statistics Canada Catalogue 15-506E [30], pages 15-17 and page 20.

[10]Statistics Canada Catalogue 67-202 [33], page 8.

[11]Statistics Canada Catalogue 61-202 [33], page 9. See also Census of Manufacturers: Concepts and Definitions.

[12]I-O Statistics Canada Catalogue 15-506E [30], pages 24-25. Certain parts have been emphasized by the author.

[13]Comparisons, for 1971, of the estimates of value added and the gross output from I-O and census of manufacturing data are given below:

| | Value Added ($M) | | | Gross Output ($M) | | |
|---|---|---|---|---|---|---|
| | | Census of Mfg. | | | | |
| | I-O | Total Act. | Own Mfg. | I-O | Total Act. | Own Mfg. |
| Primary Metal | 1732.0 | 1841.7 | 1812.1 | 5118.0 | 4490.3 | 3963.3 |

SOURCES: Statistics Canada Catalogue 31-203, 1971 [27], Table 4; Statistics Canada 15-506E, [30] Table 86.

[14]"Output represents a measure of production, not of shipments or sales. Similarly, inputs are a measure of the use of purchased inputs and not a measure of purchases." Statistics Canada Catalogue 15-506E, [30] page 26.

[15]See Statistics Canada Catalogue 15-506E [30] page 27.

[16]Concepts and Definitions, Census of Manufacturers - Statistics Canada Catalogue No. 31-203P, [22] 1966. The emphasis is in the original text.

[17]See Statistics Canada Catalogue 57-206, 1975 [26], page 17, for statistics relating to the private generation of electricity. See also the proceeding section of this Appendix and Tables A.3, A.4 and A.5.

[18]Taken from G. Protti [17], pages 8 to 11.

[19]Note also that the cost of labour and raw materials used to generate the electricity are included in the industry input tables with the result that the direct electricity coefficients in the above mentioned industries are likely to be considerably underestimated

[20]Appendix B provides more detail of the 'BTU' tables.

[21]In 1966 the ratio of purchased to own generated electricity by all industries was 4.3. In 1971 it had grown to 5.2 (Data obtained from the Structural Analysis Branch, Statistics Canada).

# APPENDIX B

## DIRECT ENERGY COEFFICIENTS: A COMPARISON OF METHODS OF MEASUREMENT

### B.1 Introduction

This appendix is an examination of the use of two measures of energy commodity usage. The two measures are those of Btu energy equivalences and the dollar values spent on energy commodities. They are examined in the context of an exercise to measure the changing direct energy consumption per dollar of output produced among industries in the input-output tables. The point of interest is the extent and possible reasons for the differences in the two measures of direct energy consumption by industries.

Both sets of information have been derived from the Structural Analysis Division of Statistics Canada. The Btu measures form part of Statistics Canada's Energy Input-Output model. Information was supplied from this source along with details concerning the calculation of the Btu estimates. See Section B.4 for information on such calculations. The price data were obtained from the input-output tables expressed in constant (1961) prices. The two years compared were 1966 and 1971.

### B.2 Methods of Measurement: Btus vs Dollar Measures

The dollar measures of energy are presented in 'real' dollars and are calculated at producers' prices[1] per natural unit (i.e. ton, kWh). The British thermal unit, or Btu, is a calorific

unit representing the amount of heat necessary 'to raise the temperature of one pound of water one degree Fahrenheit'.[2]

The Btu calculation was made with the aid of information supplied in correspondence with Statistics Canada. (See Section B.4 of this appendix for details of that correspondence.) All Btu figures received from this source were stated in terms of 'input' Btus. In order to avoid confusion between 'input' and 'output' Btus and 'input-output analysis' one should note at this stage that 'input' Btus are stated as such because they do not take into account the efficiency of utilization factors of the various energy commodities. 'Output' Btus are 'input' Btus adjusted by a chosen 'utilization efficiency factor'. Table B.1 reveals the utilization efficiency factors for residential, commercial and industrial sectors of the economy. The proceeding table, Table B.2, is presented to help clarify the technique used by Statistics Canada in their computation of the input Btu equivalencies of different energy types.[3] In this table appear the natural units (short tons, cubic feet, gallons and kW.h) and their equivalent input Btu conversion factors. Since the Btu content of natural gas has declined in the period under review, a varying conversion factor is used by Statistics Canada in their computations.

All the Btu statistics which were obtained through correspondence with Statistics Canada were given in terms of 'input Btus'. It was therefore necessary to convert them into 'output Btus' in order to take into consideration the utilization efficiency factors of the different energy sources. This conversion process was carried out by making use of the industrial utilization efficiency factor discussed previously and presented in Table B.1. At this point, it is worth noting that this is one problem to be confronted if one is going to be working with Btu measures. Errors are easily made if Btu data are collected from different sources — some sources correcting for efficiency factors and others failing to make the same adjustments.

TABLE B.1

ENERGY UTILIZATION EFFICIENCY FACTORS (%) BY ECONOMIC SECTORS: CANADA

| Energy Commodity | Residential | Commercial | Industrial |
|---|---|---|---|
| 1 Diesel Oil | 23 | 23 | 26 |
| 2 Light Fuel Oil | 65 | 82 | 82 |
| 3 Heavy Fuel Oil | 80 | 80 | 87 |
| 4 Motor Gasoline | -- | -- | 20 |
| 5 LPG | 75 | 78 | 85 |
| 6 Kerosene | 55 | 82 | 82 |
| 7 Coal | -- | 65 | 87 |
| 8 Electricity | 100 | 100 | 100 |
| 9 Natural Gas | 75 | 78 | 85 |

SOURCE: M. Fuss, R. Hyndman, L. Wavermann [38].

NOTES: (a) Numbers 1, 2, 3 and 4 correspond to classification "Gasoline and Fuel Oil," Numbers 5 and 6 to "Other Petroleum and Coal Products," Number 7 to "Coal," Number 8 to "Electricity" and Number 9 to "Natural Gas."

(b) For the purposes of this analysis, the concept of 'utilization efficiency' is used to mean the ratio between useful energy output ($BTU_o$) and raw energy input ($BTU_i$). It is well known that this ratio which measures 'utilization efficiency' has changed over the years predominantly towards a fuller utilization of the inherent energy contained in the commodity. Utilization efficiency is dependent mainly on the end uses to which energy commodities are put, on the equipment in which they are used, and on the type of energy commodity used.

TABLE B.2

ENERGY COMMODITIES: NATURAL UNITS AND THEIR INPUT BTU CONVERSION FACTORS

| Energy Commodity | Natural Unit | Conversion Factor[a] |
|---|---|---|
| Coal | | |
| Anthracite | short tons of 2,000 lbs. | 25.4000 |
| Imported Bituminous | short tons of 2,000 lbs. | 25.8000 |
| Canadian Bituminous | short tons of 2,000 lbs. | 25.2000 |
| Sub-Bituminous | short tons of 2,000 lbs. | 17.0000 |
| Lignite | short tons of 2,000 lbs. | 13.2000 |
| Coke | short tons of 2,000 lbs. | 24.8000 |
| Coke Oven Gas | '000 cubic feet | 0.5000 |
| Liquefied Petroleum Gases | barrels of 35 Canadian gallons | 4.0950 |
| Crude Oil | barrels of 35 Canadian gallons | 5.8030 |
| Still Gas | barrels of 35 Canadian gallons | 6.2874 |
| Motor Gasoline | barrels of 35 Canadian gallons | 5.2220 |
| Kerosene | barrels of 35 Canadian gallons | 5.6770 |
| Diesel | barrels of 35 Canadian gallons | 5.8275 |
| Light Fuel Oil | barrels of 35 Canadian gallons | 5.8275 |
| Heavy Fuel Oil | barrels of 35 Canadian gallons | 6.2874 |
| Petroleum Coke | barrels of 35 Canadian gallons | 6.3852 |
| Aviation Gasoline | barrels of 35 Canadian gallons | 5.0505 |
| Aviation Turbo Fuel | barrels of 35 Canadian gallons | 5.4145 |
| Natural Gas | '000 cubic feet | 1.0700/1.0000 |
| Electricity | '000 kWh | 3.4120 |

SOURCE: S.C. Catalogue 57-505 Occasional [25], p.3.

NOTE: (a) Conversion Factor into 'input' BTU equivalents. BTUs - '000,000

Table B.3 contains some actual Btu conversions. This conversion process, however, works backwards from the process just described. The price per million 'input' Btus is calculated given the price per million 'output' Btus for nine energy commodities in 1966 and 1971. To make this conversion, one multiplies the price per million 'output' Btus by the utilization efficiency factor:

$$\$/Btu_i = \$/Btu_o \cdot X$$

where $\$/Btu_i$ = price per million 'input' Btus
$\$/Btu_o$ = price per million 'output' Btus
$X$ = utilization efficiency factor.

The result of this Btu conversion process is to express Btus in price per million 'input' Btus given the price per million 'output' Btus.

The preceeding table of conversions from 'output' to 'input' Btus uses statistics derived from the 'Total Manufacturing Industry' in 'Ontario'. The source[4] of these statistics presents annual data on a regional basis beginning in 1962 through to 1974. Four regions are detailed: Quebec, Ontario, the Prairies and British Columbia, and statistics are recorded for twelve industries in each of these regions. The price per million output Btus, the quantity in millions of output Btus and the cost share that each energy source comprises in the energy bill are reported for five different energy commodities: oil, natural gas, electricity, gasoline and liquified petroleum gas (LPG) in each of the four regions.

Table B.4 is an excerpt from this source and presents data sequentially for 'Total Manufacturing' in 'Ontario'. Reading across the table for the year 1971, one can see that 91,930 million output Btus of oil were consumed in total manufacturing at a price of $0.76 per million output Btus. For this year, the energy cost share for oil was 0.1560 of the total energy bill for oil, natural gas, electricity, gasloine, LPG and coal in Ontario manufacturing.

TABLE B.3

CONVERSIONS FROM 'OUTPUT' TO 'INPUT' BTUs[b]: 1966 AND 1971

| Energy Inputs Ranked by Utilization Efficiency | Industrial Utilization Efficiency Factor[a] | $/million BTU Output 1966 | $/million BTU Output 1971 | $/million BTU Input 1966 | $/million BTU Input 1971 |
|---|---|---|---|---|---|
| Electricity | 100 | 2.00 | 2.50 | 2.00 | 2.50 |
| Coal | 87 | .50 | .86 | .43 | .75 |
| Heavy Fuel Oil | 87 | .63 | .76 | .55 | .66 |
| LPG | 85 | 2.26 | 2.17 | 1.93 | 1.85 |
| Natural Gas | 85 | .65 | .66 | .56 | .56 |
| Kerosene | 82 | 2.26 | 2.17 | 1.85 | 1.78 |
| Light Fuel Oil | 82 | 2.26 | 2.17 | 1.85 | 1.78 |
| Diesel Oil | 26 | .63 | .76 | .16 | .20 |
| Motor Gasoline | 20 | 11.98 | 13.73 | 2.40 | 2.75 |

SOURCES: See Tables B.1 and B.4.

NOTES: (a) Taken from Table B.1, the last column
(b) For discussion concerning this conversion process, refer to the main text, Section B.2.

TABLE B.4

ENERGY DATA FOR TOTAL MANUFACTURING INDUSTRY: 1962 TO 1974

ONTARIO REGION[d]

| Year | OIL.Q[a] | OIL.P[b] | OIL.S[c] | NGAS.Q | NGAS.P | NGAS.S | ELEC.Q | ELEC.P | ELEC.S |
|---|---|---|---|---|---|---|---|---|---|
| 1962 | 56186 | .63 | .1561 | 56404 | .57 | .1412 | 48091 | 1.97 | .4169 |
| 1963 | 63971 | .62 | .1650 | 61864 | .59 | .1502 | 51035 | 1.98 | .4178 |
| 1964 | 73027 | .62 | .1698 | 71321 | .60 | .1621 | 55538 | 1.98 | .4134 |
| 1965 | 82563 | .62 | .1740 | 75923 | .64 | .1631 | 60688 | 2.01 | .4114 |
| 1966 | 87714 | .63 | .1725 | 84874 | .65 | .1708 | 66728 | 2.00 | .4150 |
| 1967 | 91781 | .63 | .1722 | 90569 | .67 | .1819 | 68075 | 2.04 | .4145 |
| 1968 | 90697 | .63 | .1607 | 106494 | .66 | .1983 | 72943 | 2.08 | .4277 |
| 1969 | 88045 | .63 | .1501 | 124197 | .66 | .2208 | 73955 | 2.24 | .4490 |
| 1970 | 90632 | .64 | .1426 | 153303 | .64 | .2425 | 78763 | 2.36 | .4588 |
| 1971 | 91930 | .76 | .1560 | 172471 | .66 | .2541 | 80663 | 2.50 | .4541 |
| 1972 | 98747 | .80 | .1646 | 193328 | .67 | .2705 | 83671 | 2.60 | .4510 |
| 1973 | 93266 | .88 | .1514 | 214429 | .71 | .2790 | 88169 | 2.86 | .4645 |
| 1974 | 98007 | 1.33 | .1960 | 237131 | .81 | .2908 | 90445 | 3.11 | .4235 |

| Year | GAS.Q | GAS.P | GAS.S | LPG.Q | LPG.P | LPG.S | COAL.Q | COAL.P | COAL.S |
|---|---|---|---|---|---|---|---|---|---|
| 1962 | 1445 | 11.08 | .0706 | 551 | 2.01 | .0049 | 96027 | .50 | .2102 |
| 1963 | 1560 | 11.14 | .0718 | 637 | 2.06 | .0054 | 95417 | .48 | .1897 |
| 1964 | 1695 | 11.56 | .0736 | 944 | 2.18 | .0077 | 98972 | .47 | .1734 |
| 1965 | 1824 | 11.74 | .0722 | 899 | 2.18 | .0066 | 106088 | .48 | .1727 |
| 1966 | 1962 | 11.98 | .0732 | 937 | 2.26 | .0066 | 104278 | .50 | .1619 |
| 1967 | 1960 | 12.25 | .0717 | 960 | 2.28 | .0065 | 97932 | .52 | .1532 |
| 1968 | 1973 | 12.88 | .0716 | 1554 | 2.19 | .0096 | 85699 | .55 | .1320 |
| 1969 | 2035 | 13.15 | .0726 | 1442 | 2.17 | .0085 | 65089 | .56 | .0990 |
| 1970 | 1953 | 13.50 | .0650 | 1157 | 2.22 | .0063 | 48457 | .71 | .0848 |
| 1971 | 1935 | 13.73 | .0597 | 1540 | 2.17 | .0075 | 35461 | .86 | .0686 |
| 1972 | 1895 | 14.07 | .0553 | 2629 | 2.38 | .0130 | 26559 | .83 | .0456 |
| 1973 | 1863 | 15.19 | .0521 | 1257 | 2.35 | .0054 | 22611 | 1.14 | .0476 |
| 1974 | 1934 | 17.83 | .0519 | 1633 | 2.95 | .0073 | 15069 | 1.35 | .0306 |

SOURCE: R.N. McRae and A.R. Webster [16], pp.16 and 18.

NOTES: [a]Each fuel quantity is measured in millions of output BTUs.

[b]Each fuel price is measured in dollars per million output BTUs.

[c]Each fuel cost share is measured as the fuel cost as a proportion of the total fuel cost for the industry.

[d]The following symbols are used in Table B.4:

| | |
|---|---|
| fuel.Q | quantity of the 'fuel' used, million output BTUs. |
| fuel.P | price of the 'fuel', $(current)/million output BTU. |
| fuel.S | cost share of the 'fuel'. |
| OIL | fuel oil, aggregate consisting of kerosene, diesel, light fuel oil and heavy fuel oil. |
| NGAS | natural gas |
| ELEC | electricity |
| GAS | motor gasoline |
| LPG | liquified petroleum gases |
| COAL | coal aggregated consisting of lignite, sub-bituminous, bituminous, imported bituminous, anthracite and coke. |

## B.3 Some Assumptions Embodied In Input-Output Analysis

The "Btu input-output tables" used in the Statistics Canada model embody several assumptions, including one concerning the type of Btus (input or output) used and another concerning the utilization efficiency of different energy resources. First, only input Btus are used. This means that no adjustment is made for the utilization efficiency factors of different energy resources. Secondly, the Btu input-output analysis assumes that there is constancy in the efficiency of energy use. In other words, it assumes that there is constancy in the technology which determines the efficiency of the use of the energy commodities.

These assumptions may give rise to problems. For example, what if there should be advances in utilization technologies motivated by large rises in the price of energy? The sharp increase in the price of oil in 1974 may be used as an illustration of this point. This large price rise could have provided the motivation for oil consumers to innovate, for instance, in improving in their use of oil. This motivation could have been particularly strong for those consumers of oil who could not easily move to another energy commodity. This reasoning suggests that some improvements in the efficient uses of oil could have taken place during and after 1974. To use the efficiency rates assumed in 1971 for these later years could introduce an error into the calculations.

Direct energy coefficients have been calculated (refer to Tables B.5, B.6, B.7 and B.8) using different measures (dollar and Btu measures) for 1966 and 1971. One would tend to think on first inspection of the results that the measures contradict each other in a number of instances. This would appear to be the case where the total direct energy coefficient ratios[5] (1971/1966 total direct energy coefficients) are less than 1.0 in one measure (i.e. value of total energy consumed per unit value of output produced)

TABLE B.5

1966 AGGREGATED DIRECT ENERGY COEFFICIENTS: BTU/$ 1966 OUTPUT (1961 prices)

| Industry | Gasoline & Fuel Oil | Other Petroleum & Coal Products | Coal | Electricity[a] | Natural Gas | Total Energy[b] |
|---|---|---|---|---|---|---|
| 1. Agriculture | .0258727 | .0004616 | .0005042 | .0037470 | .0012166 | .0318021 |
| 2. Forestry | .0206871 | .0004878 | .0003494 | .0005900 | .0000143 | .022128 |
| 3. Fishing, Hunting & Trapping | .1073262 | .0000435 | -- | .0004513 | .0011462 | .1089673 |
| 4. Metal Mines | .0172951 | .0002531 | .0011106 | .0145347 | .0020409 | .0352343 |
| 5. Mineral Fuels | .0048845 | .0001877 | .0010949 | .0031748 | .0943106 | .1036525 |
| 6. Non-Metal Mines & Quarries | .0214191 | .0000599 | .0042709 | .0088164 | .0249591 | .0595253 |
| 7. Services Incidental to Mining | .0597749 | -- | -- | .0040217 | -- | .0637967 |
| 8. Food & Beverage | .0074839 | .0001026 | .0009840 | .0014722 | .0039975 | .0140403 |
| 9. Tobacco Products | .0019899 | .0000907 | .0002203 | .0007615 | .0005816 | .0036441 |
| 10. Rubber & Plastics Products | .0064785 | .0000197 | .0017912 | .0030758 | .0017634 | .0131287 |
| 11. Leather | .0032049 | .0000032 | .0017595 | .0011909 | .0008153 | .0069739 |
| 12. Textiles | .0115607 | .0000363 | .0011898 | .0034303 | .0023200 | .0185371 |
| 13. Knitting Mills | .0038802 | -- | .0014368 | .0009509 | .0008633 | .0071313 |
| 14. Clothing | .0007776 | .0000098 | .0000581 | .0004874 | .0004634 | .0017963 |
| 15. Wood | .0056416 | .0003564 | .0007001 | .0053972 | .0021232 | .0142185 |
| 16. Furniture Fixtures | .0023071 | .0000184 | .0007471 | .0013991 | .0014458 | .0059175 |
| 17. Paper & Allied | .0361435 | .0003349 | .0177748 | .0266673 | .0106062 | .0915266 |
| 18. Printing & Publishing | .0019165 | .0000134 | .0002178 | .0013801 | .0010449 | .0045726 |
| 19. Primary Metal | .0158671 | .0322206 | .0482914 | .0256741 | .0107999 | .1328531 |
| 20. Metal Fabricating | .0027986 | .0002165 | .0006301 | .0015178 | .0038823 | .0090453 |
| 21. Machinery | .0020163 | .0002487 | .0016938 | .0010674 | .0018639 | .0068900 |
| 22. Trans. Equipment | .0021544 | .0003379 | .0027772 | .0014466 | .0015069 | .0082229 |
| 23. Electrical Products | .0023985 | .0000969 | .0007924 | .0017085 | .0011393 | .0061356 |
| 24. Non-Metal Mineral Products | .0245582 | .0005348 | .0281236 | .0106478 | .0331700 | .0970344 |
| 25. Petroleum & Coal Products | .0502245 | .0015498 | .0049334 | .0036355 | .0057333 | .0660766 |
| 26. Chemical & Chemical Products | .0113329 | .0086582 | .0170827 | .0134820 | .0247272 | .0752831 |
| 27. Miscellaneous Manuf. | .0023392 | .0000416 | .0010411 | .0010747 | .0012254 | .0057219 |
| 28. Construction | .0166402 | .0002838 | .0013945 | .0004564 | -- | .0187749 |
| 29. Transportation & Storage | .0525248 | .0002297 | .0014039 | .0017407 | .0108886 | .0667877 |
| 30. Communications | .0032012 | .0000739 | -- | .0008181 | .0001782 | .0042715 |
| 31. Electric Power Gas & Other Utilities | .0259349 | -- | .1149918 | .0321746 | .0444822 | .2175835 |
| 32. Wholesale Trade | .0152013 | .0003909 | .0002852 | .0024338 | .0026419 | .0209531 |
| 33. Retail Trade | .0082083 | .0000177 | -- | .0007101 | .0121382 | .0210744 |
| 34. Owner Occupied Dwell. | -- | -- | -- | -- | -- | -- |
| 35. Finance Ins. & Real Est. | .0061459 | -- | -- | .0016009 | .0055444 | .0132914 |
| 36. Education & Health Serv. | .0018416 | .0002829 | .0002988 | .0013686 | .0028303 | .0066221 |
| 37. Amusement & Rec. Serv. | .0052929 | .0002452 | -- | .0081873 | .0002562 | .0139815 |
| 38. Service to Business Man. | .0133262 | .0000327 | -- | .0007273 | .0001429 | .0142291 |
| 39. Accommodation, Food Serv. | .0132413 | .0003438 | -- | .0019664 | .0033959 | .0189475 |
| 40. Personal & Misc. Serv. | .0103028 | .0006809 | -- | .0041683 | .0004551 | .0156070 |
| 41. Transport. Margins | -- | -- | -- | -- | -- | -- |
| 42. Operating Office, Lab. & Food. | -- | -- | -- | -- | -- | -- |
| 43. Travel Promotion & Advertising. | .0300550 | -- | -- | -- | -- | .0300550 |

SOURCES: S.C. Catalogue 15-506E [29].
Statistics Canada, Structural Analysis Division

TABLE B.6

1971 AGGREGATED DIRECT ENERGY COEFFICIENTS BTU/$ 1971 OUTPUT (1961 prices)

| Industry | Gasoline & Fuel Oil | Other Petroleum & Coal Products | Coal | Electricity[a] | Natural Gas | Total Energy[b] |
|---|---|---|---|---|---|---|
| 1. Agriculture | .0338409 | .0009987 | .0003470 | .0035559 | .0014718 | .0402144 |
| 2. Forestry | .0183294 | .0002736 | .0000027 | .0001856 | .0000490 | .0188403 |
| 3. Fishing, Hunting & Trapping | .0986308 | .0000884 | -- | .0003563 | .0009528 | .1000282 |
| 4. Metal Mines | .0229138 | .0004301 | .0007688 | .0195778 | .0075272 | .0512176 |
| 5. Mineral Fuels | .0009162 | .0000240 | .0003116 | .0034840 | .0726033 | .0773392 |
| 6. Non-Metal Mines & Quarries | .0249479 | .0002283 | .0008405 | .0111859 | .0356543 | .0729069 |
| 7. Services Incidental to Mining | -- | -- | -- | .0038289 | -- | .0038289 |
| 8. Food & Beverage | .0061401 | .0001454 | .0000665 | .0015261 | .0048523 | .0127304 |
| 9. Tobacco Products | .0018807 | .0000204 | .0000093 | .0010075 | .0006588 | .0035767 |
| 10. Rubber & Plastics Products | .0007133 | .0000506 | .0000778 | .0031905 | .0025137 | .0065458 |
| 11. Leather | .0036995 | .0000068 | .0003209 | .0012290 | .0022924 | .0075486 |
| 12. Textiles | .0091804 | .0002373 | .0001004 | .0036632 | .0035155 | .0166968 |
| 13. Knitting Mills | .0038698 | .0000007 | .0003293 | .0012114 | .0012877 | .0066989 |
| 14. Clothing | .0006352 | .0000124 | .0000013 | .0007438 | .0003737 | .0017664 |
| 15. Wood | .0057452 | .0004991 | .0001026 | .0058764 | .0040977 | .0163210 |
| 16. Furniture Fixtures | .0022375 | .0000621 | .0004015 | .0013795 | .0022586 | .0063392 |
| 17. Paper & Allied | .0452607 | .0003334 | .0044549 | .0266107 | .0193627 | .0960225 |
| 18. Printing & Publishing | .0144499 | .0000105 | .0000119 | .0015409 | .0012902 | .0173035 |
| 19. Primary Metal | .0138027 | .0349068 | .0089118 | .0263149 | .0163756 | .1003118 |
| 20. Metal Fabricating | .0021886 | .0001967 | .0000929 | .0015922 | .0043446 | .0084151 |
| 21. Machinery | .0016708 | .0001568 | .0002265 | .0013629 | .0031808 | .0065978 |
| 22. Trans. Equipment | .0018096 | .0003669 | .0007810 | .0014218 | .0001965 | .0045758 |
| 23. Electrical Products | .0018202 | .0000767 | .0001714 | .0016249 | .0019668 | .0056600 |
| 24. Non-Metal Mineral Products | .0297105 | .0032750 | .0058624 | .0099139 | .0470776 | .0958395 |
| 25. Petroleum & Coal Products | .0009558 | .0014600 | .0034314 | .0044475 | .007755 | .0180506 |
| 26. Chemical & Chemical Products | .0136857 | .0066193 | .0014586 | .0172024 | .0393686 | .0783346 |
| 27. Miscellaneous Manuf. | .0027534 | .0000471 | .0004721 | .0014475 | .0018601 | .0065802 |
| 28. Construction | .0079471 | .0005115 | .0007715 | .0001467 | -- | .0093767 |
| 29. Transportation & Storage | .0468259 | .0015625 | .0007511 | .0025088 | .0191642 | .0708125 |
| 30. Communications | .0019165 | .0001304 | -- | .0010932 | .0001489 | .0032889 |
| 31. Electric Power Gas & Other Utilities | .0378678 | .0000424 | .0778870 | .0311543 | .0368366 | .1837882 |
| 32. Wholesale Trade | .0160339 | .0008247 | .0000395 | .0015603 | .0024568 | .0209152 |
| 33. Retail Trade | .0094401 | .0000301 | -- | .0043987 | .0131358 | .0270047 |
| 34. Owner Occupied Dwell. | -- | -- | -- | -- | -- | -- |
| 35. Finance Ins. & Real Est. | .0037703 | .0004875 | -- | .0021608 | .0074551 | .0138738 |
| 36. Education & Health Serv. | .0078335 | .0004306 | .0008854 | .0008165 | .0017366 | .0117026 |
| 37. Amusement & Rec. Serv. | .0084133 | .0000693 | -- | .0054355 | .0003596 | .0142777 |
| 38. Service to Business Man. | .0039313 | .0008784 | -- | .0006852 | .0001126 | .0056076 |
| 39. Accommodation, Food Serv. | .0179601 | .0014666 | -- | .0039266 | .0050126 | .0283659 |
| 40. Personal & Misc. Serv. | .0205968 | -- | -- | .0033687 | .0004098 | .0243754 |
| 41. Transport. Margins | -- | -- | -- | -- | -- | -- |
| 42. Operating Office, Lab. & Food. | -- | -- | -- | -- | -- | -- |
| 43. Travel Promotion & Advertising. | .0237216 | -- | -- | -- | -- | .0237216 |

SOURCES: S.C. Catalogue 15-506E [29].
Statistics Canada, Structural Analysis Division.

TABLE B.7

1966 AGGREGATED DIRECT ENERGY COEFFICIENTS: $ ENERGY CONSUMPTION/$ OUTPUT 1966 OUTPUT (1961 prices)

| Industry | Gasoline & Fuel Oil | Other Petroleum & Coal Products | Coal | Electricity[a] | Natural Gas | Total Energy[b] |
|---|---|---|---|---|---|---|
| 1. Agriculture | .0343751 | .0061968 | .0002684 | .0092708 | .0001708 | .0502819 |
| 2. Forestry | .0246097 | .0011925 | .0002168 | .0020598 | -- | .0280788 |
| 3. Fishing, Hunting & Trapping | .0461441 | .0075853 | -- | .0012642 | -- | .0549936 |
| 4. Metal Mines | .0101368 | .0017377 | .0006517 | .0260662 | .0002172 | .0388096 |
| 5. Mineral Fuels | .0034709 | .0009381 | .0005629 | .0160413 | .0006567 | .0216699 |
| 6. Non-Metal Mines & Quarries | .0186576 | .0052332 | .0031854 | .0204778 | .0015927 | .0491467 |
| 7. Services Incidental to Mining | .0201444 | .0072216 | -- | .0098823 | -- | .0372483 |
| 8. Food & Beverage | .0056994 | .0008231 | .0004504 | .0044415 | .0004348 | .0118492 |
| 9. Tobacco Products | .0010428 | .0002606 | -- | .0020855 | -- | .0033889 |
| 10. Rubber & Plastics Products | .0024076 | .0021668 | .0006019 | .0069821 | .0002408 | .0123992 |
| 11. Leather | .0015124 | .0003025 | .0009074 | .0039323 | -- | .0066546 |
| 12. Textiles | .0043193 | .0005399 | .0005399 | .0069418 | .0002314 | .0125723 |
| 13. Knitting Mills | .0015828 | -- | .0006331 | .0034821 | -- | .005698 |
| 14. Clothing | .0007709 | .0000964 | .0001927 | .0022164 | -- | .0032764 |
| 15. Wood | .0058577 | .0036159 | .0001446 | .0096182 | .0002169 | .0194533 |
| 16. Furniture Fixtures | .0017406 | .0001741 | .0003481 | .0052219 | .0001741 | .0076588 |
| 17. Paper & Allied | .0119864 | .0046614 | .0069548 | .0283013 | .0010655 | .0529734 |
| 18. Printing & Publishing | .0014058 | .0006560 | .0000937 | .0044049 | .0001874 | .0067478 |
| 19. Primary Metal | .0071062 | .0093986 | .0211754 | .0165334 | .0012608 | .0554744 |
| 20. Metal Fabricating | .0018544 | .0008159 | .0001854 | .0043764 | .0006305 | .0078626 |
| 21. Machinery | .0016529 | .0008901 | .0003179 | .0031788 | .0003815 | .0064212 |
| 22. Trans. Equipment | .0012836 | .0008557 | .0011172 | .0033279 | .0002615 | .0068459 |
| 23. Electrical Products | .0011067 | .0007083 | .0003541 | .0038513 | .0001771 | .0061975 |
| 24. Non-Metal Mineral Products | .0129673 | .0048273 | .0111689 | .0197823 | .0031235 | .0518693 |
| 25. Petroleum & Coal Products | .0002535 | .0092534 | .0011408 | .0065281 | .0003803 | .0175561 |
| 26. Chemical & Chemical Products | .0047747 | .0340473 | .0064257 | .0169567 | .0019634 | .0641678 |
| 27. Miscellaneous Manuf. | .0018585 | .0013629 | .0004956 | .0044604 | .0003717 | .0085491 |
| 28. Construction | .0097250 | .0077842 | .0007212 | .0005303 | -- | .0187607 |
| 29. Transportation & Storage | .0339323 | .0021208 | .0006284 | .0043004 | .0011782 | .0421601 |
| 30. Communications | .0013588 | .0002471 | -- | .0020382 | -- | .0036441 |
| 31. Electric Power Gas & Other Utilities | .0099456 | .0001989 | .0310967 | .0135261 | .0017239 | .0564912 |
| 32. Wholesale Trade | .0099181 | .0009298 | .0001549 | .0060180 | .0003358 | .0173566 |
| 33. Retail Trade | .0053659 | .0003031 | -- | .0175773 | .0015509 | .0247972 |
| 34. Owner Occupied Dwell. | -- | -- | -- | -- | -- | -- |
| 35. Finance Ins. & Real Est. | .0017922 | .0000177 | -- | .0043651 | .0007275 | .0069025 |
| 36. Education & Health Serv. | .0047069 | .0006418 | .0009628 | .0034232 | .0003209 | .0100556 |
| 37. Amusement & Rec. Serv. | .0039559 | .0002826 | -- | .0203447 | -- | .0245832 |
| 38. Service to Business Man. | .0020551 | .0002569 | -- | .0017982 | -- | .0041102 |
| 39. Accommodation, Food Serv. | .0069653 | .0002679 | -- | .0065366 | .0006965 | .0144663 |
| 40. Personal & Misc. Serv. | .0100389 | .0079056 | -- | .0102899 | -- | .0282344 |
| 41. Transport. Margins | -- | -- | -- | -- | -- | -- |
| 42. Operating Office, Lab. & Food. | -- | .0014245 | -- | -- | -- | .0014245 |
| 43. Travel Promotion & Advertising. | .0118185 | .0011305 | -- | -- | -- | .012949 |

SOURCE: S.C. Catalogue 15-506E [29].

TABLE B.8

1971 AGGREGATED DIRECT ENERGY COEFFICIENTS: $ ENERGY CONSUMPTION/$ OUTPUT 1971 OUTPUT (1961 prices)

| Industry | Gasoline & Fuel Oil | Other Petroleum & Coal Products | Coal | Electricity[a] | Natural Gas | Total Energy[b] |
|---|---|---|---|---|---|---|
| 1. Agriculture | .03319 | .00687 | .00022 | .00808 | .00017 | .04853 |
| 2. Forestry | .01939 | .00098 | -- | .00076 | -- | .02113 |
| 3. Fishing, Hunting & Trapping | .06083 | .00956 | -- | .00137 | -- | .07176 |
| 4. Metal Mines | .01206 | .00163 | .00031 | .02828 | .00082 | .0431 |
| 5. Mineral Fuels | .00221 | .00093 | -- | .01254 | .00075 | .01643 |
| 6. Non-Metal Mines & Quarries | .01678 | .00377 | .00038 | .02131 | .00226 | .0445 |
| 7. Services Incidental to Mining | .01152 | .00474 | -- | .00644 | -- | .0227 |
| 8. Food & Beverage | .00286 | .00082 | .00007 | .00376 | .00046 | .00797 |
| 9. Tobacco Products | .00067 | .00022 | -- | .00224 | -- | .00313 |
| 10. Rubber & Plastics Products | .00214 | .00308 | -- | .00675 | .00026 | .01223 |
| 11. Leather | .00152 | .00061 | -- | .00366 | -- | .00579 |
| 12. Textiles | .00287 | .00064 | .00006 | .00603 | .00035 | .00995 |
| 13. Knitting Mills | .00139 | -- | -- | .00325 | .00023 | .00487 |
| 14. Clothing | .00034 | .000169 | -- | .00204 | -- | .002549 |
| 15. Wood | .00369 | .00326 | .00006 | .01064 | .00043 | .01808 |
| 16. Furniture Fixtures | .00124 | .00031 | .00015 | .00449 | .00031 | .0065 |
| 17. Paper & Allied | .01514 | .00404 | .00169 | .02703 | .00195 | .04985 |
| 18. Printing & Publishing | .00083 | .00058 | -- | .00396 | .00017 | .00554 |
| 19. Primary Metal | .00509 | .00720 | .01779 | .01677 | .00159 | .04844 |
| 20. Metal Fabricating | .00127 | .00093 | .00003 | .00450 | .00057 | .0073 |
| 21. Machinery | .00088 | .00063 | .00063 | .00366 | .00051 | .005743 |
| 22. Trans. Equipment | .00075 | .00072 | .00030 | .00293 | .00030 | .005 |
| 23. Electrical Products | .00069 | .00069 | .00008 | .00370 | .00023 | .00539 |
| 24. Non-Metal Mineral Products | .01174 | .00377 | .00226 | .01702 | .00453 | .03932 |
| 25. Petroleum & Coal Products | .00016 | .00739 | .00057 | .00651 | .00052 | .01515 |
| 26. Chemical & Chemical Products | .00456 | .03757 | .00067 | .01716 | .00330 | .06326 |
| 27. Miscellaneous Manuf. | .00125 | .00154 | .00029 | .00386 | .00029 | .00723 |
| 28. Construction | .00498 | .00714 | .00047 | .00046 | -- | .01305 |
| 29. Transportation & Storage | .03234 | .00208 | .00017 | .00424 | .00121 | .04004 |
| 30. Communications | .00118 | .00022 | -- | .00339 | -- | .00479 |
| 31. Electric Power Gas & Other Utilities | .01238 | .00025 | .03519 | .01150 | .00152 | .06084 |
| 32. Wholesale Trade | .01002 | .00093 | .00002 | .00482 | .00029 | .01608 |
| 33. Retail Trade | .00587 | .00033 | -- | .01358 | .00156 | .02134 |
| 34. Owner Occupied Dwell. | -- | -- | -- | -- | -- | -- |
| 35. Finance Ins. & Real Est. | .00230 | .00003 | -- | .00668 | .00088 | .00989 |
| 36. Education & Health Serv. | .00479 | .00055 | .00055 | .00251 | .00024 | .00864 |
| 37. Amusement & Rec. Serv. | .00499 | .00023 | -- | .01680 | -- | .02202 |
| 38. Service to Business Man. | .00245 | .00021 | -- | .00212 | -- | .00478 |
| 39. Accommodation, Food Serv. | .00896 | .00041 | -- | .01214 | .00058 | .02209 |
| 40. Personal & Misc. Serv. | .01244 | .00634 | -- | .01045 | -- | .02923 |
| 41. Transport. Margins | -- | -- | -- | -- | -- | -- |
| 42. Operating Office, Lab. & Food. | -- | .00147 | -- | -- | -- | .00147 |
| 43. Travel Promotion & Advertising. | .01542 | .00104 | -- | -- | -- | .01646 |

SOURCE: S.C. Catalogue 15-8066 [29].

NOTES TO TABLES B.5, B.6, B.7 AND B.8

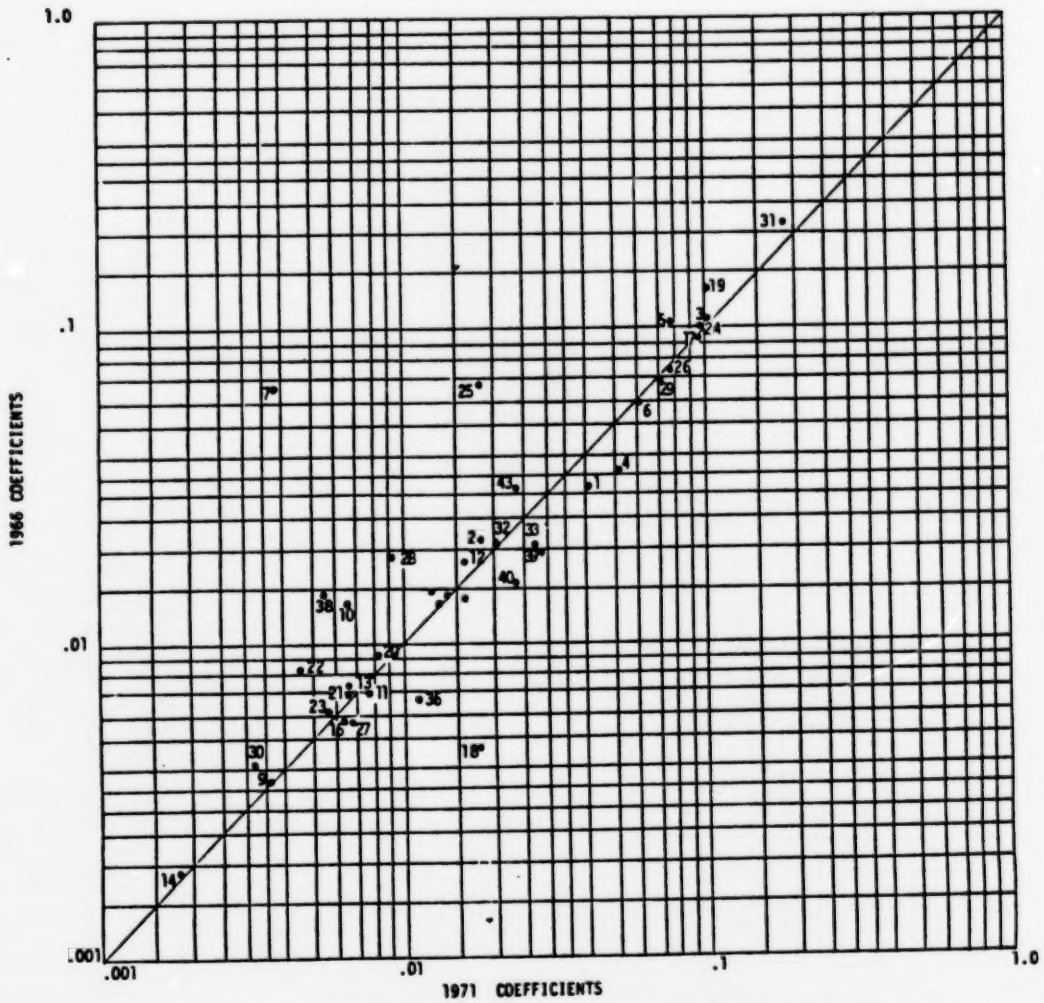
[a]The direct energy coefficients for electricity are calculated using the BTU input-output tables which measure energy flows bought and sold between industries. They do not take into account own generated electricity consumption.

[b]These 'Total Energy' figures are a summation of the direct energy coefficients of individual energy types for each industrial classification. Note that the total refers to a mixture of prime (natural gas and coal) and secondary energy commodities.

[c]The number of decimal places shown should not be interpreted as a measure of accuracy.

FIGURE B.1

TOTAL* ENERGY COEFFICIENTS: 1966 AND 1971
(10⁶ BTUs/1961 $ OUTPUT)

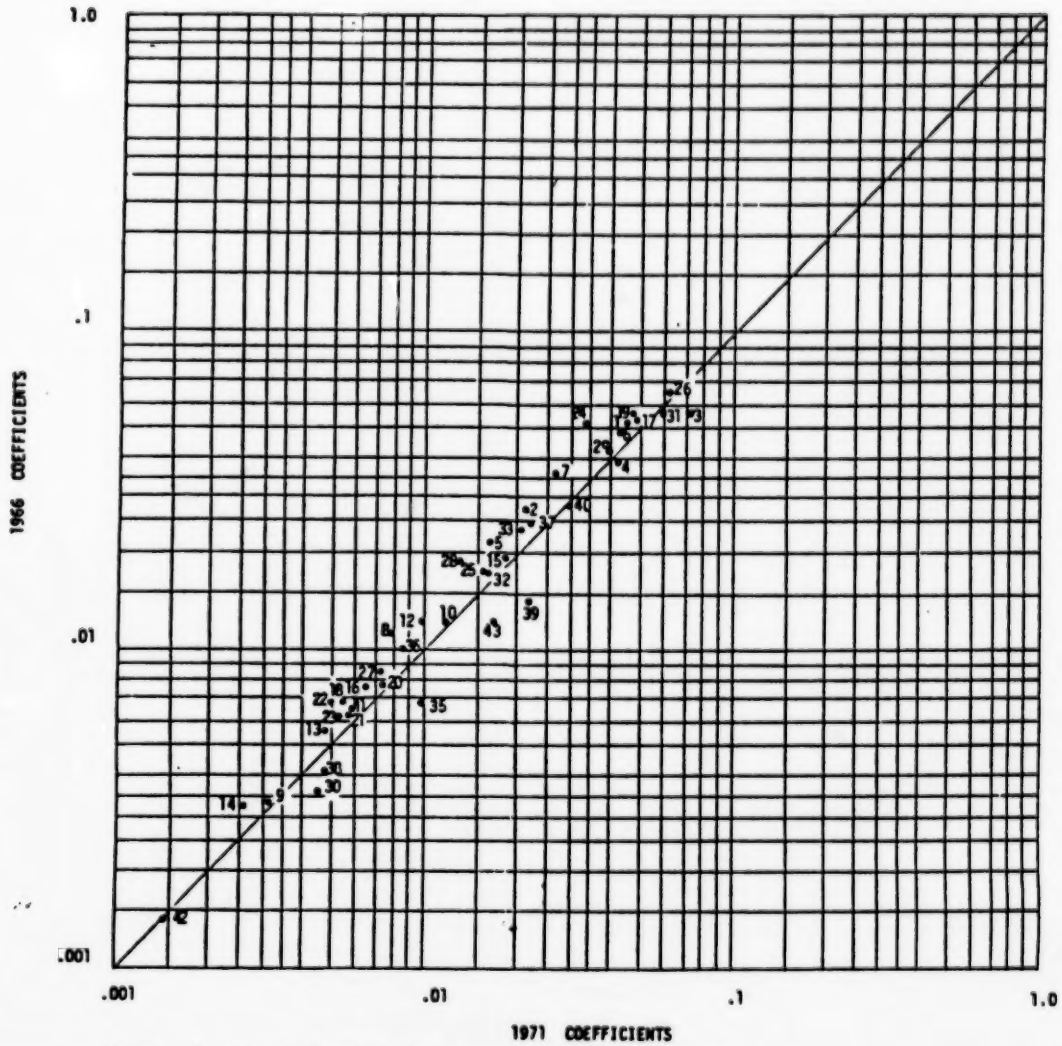



*"Total" in this sense, however, excludes figures for still gas and crude mineral oils.

SOURCES: See Tables B.5 and B.6, last columns entitled 'Total Energy'.

FIGURE B.2

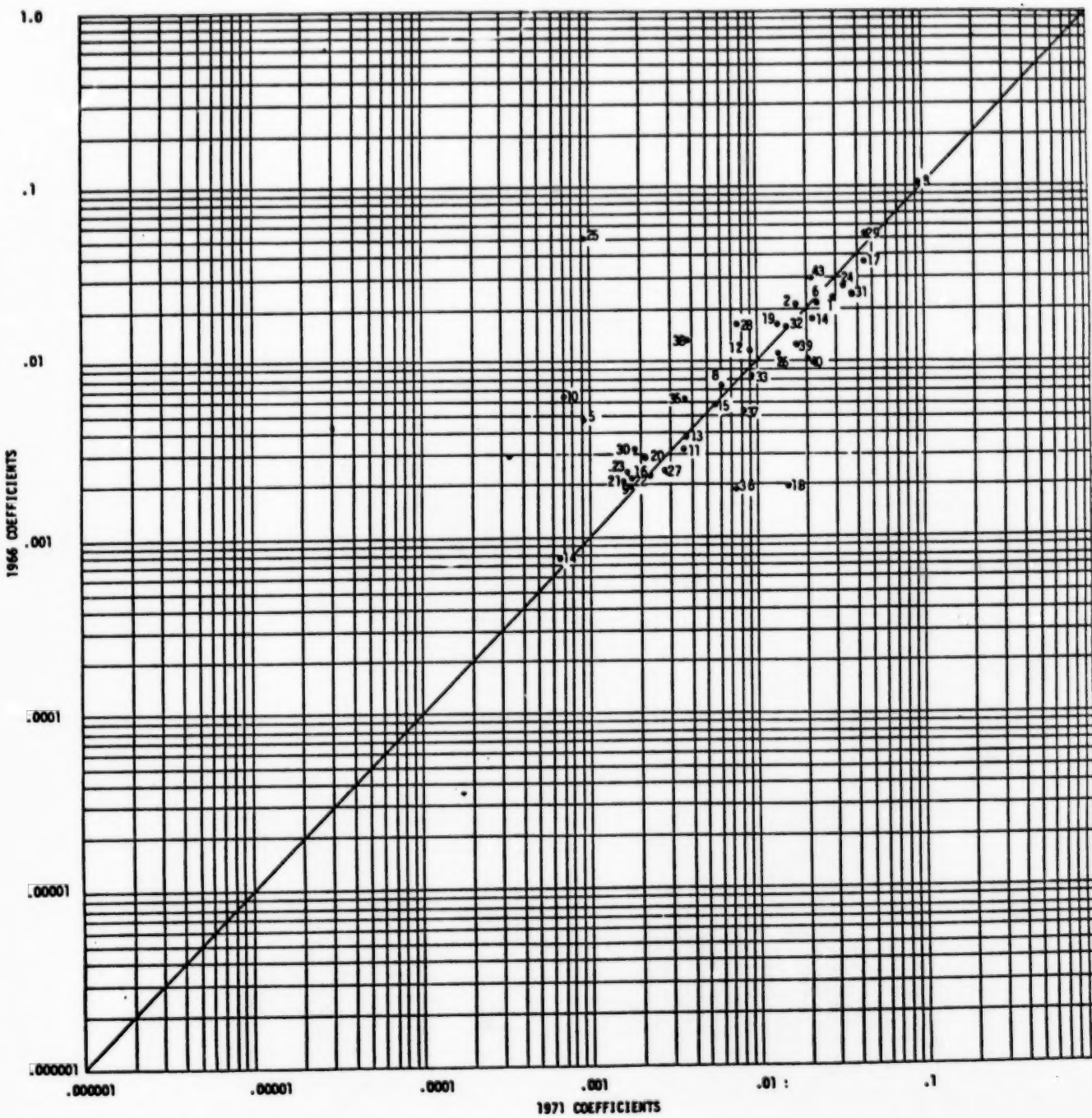
TOTAL ENERGY COEFFICIENTS: 1966 AND 1971
($ ENERGY CONSUMED/1961 $ OUTPUT)




SOURCE: See Tables B.7 and B.8, last columns entitled 'Total Energy'.

FIGURE B.3

GASOLINE & FUEL OIL COEFFICIENTS: 1966 AND 1971
($10^6$ BTUs/1961 $)

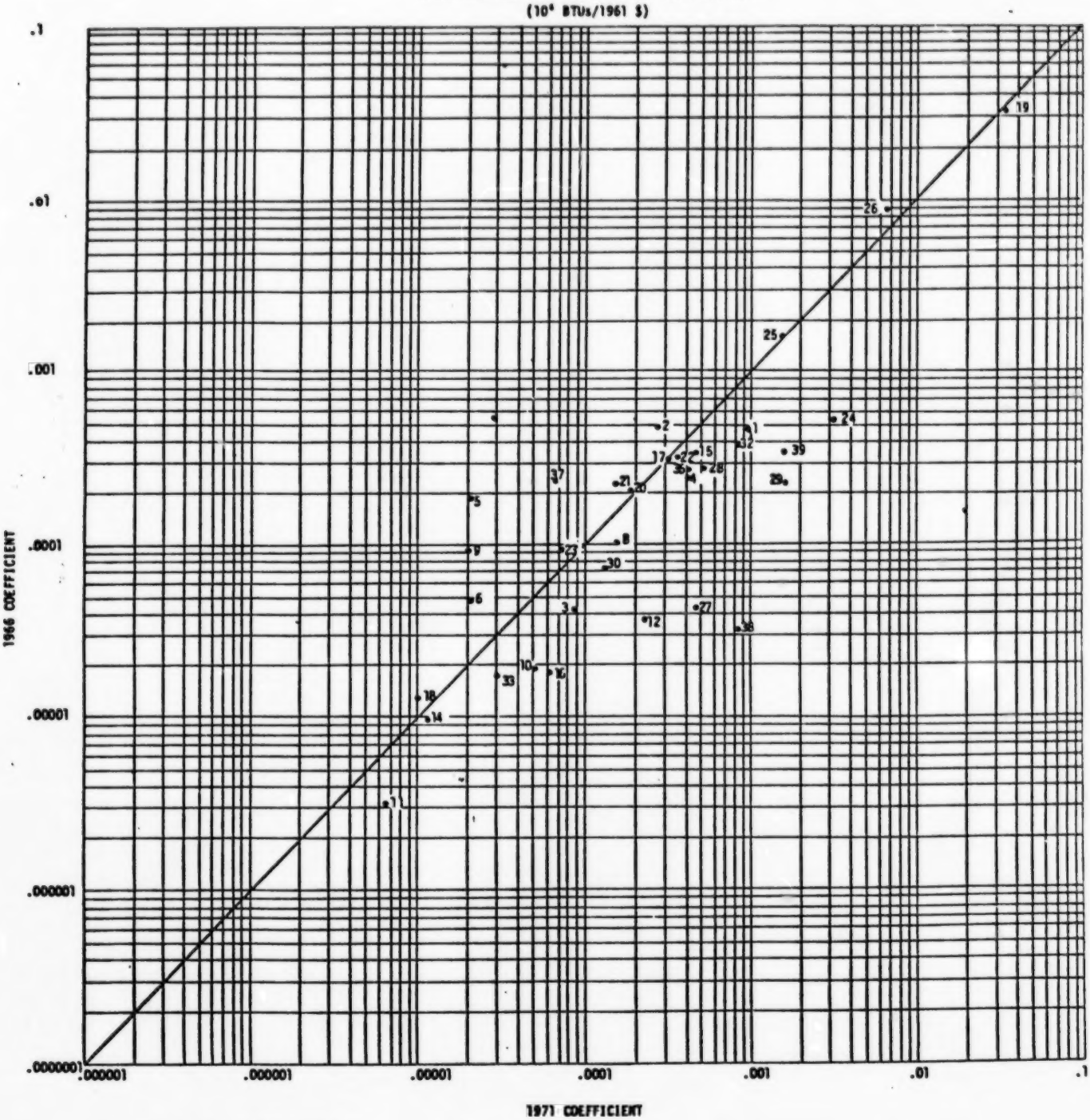



SOURCE: Refer to Tables B.5 and B.6.

FIGURE B.4

OTHER PETROLEUM & COAL PRODUCTS: 1966 AND 1971

($10^4$ BTUs/1961 $)

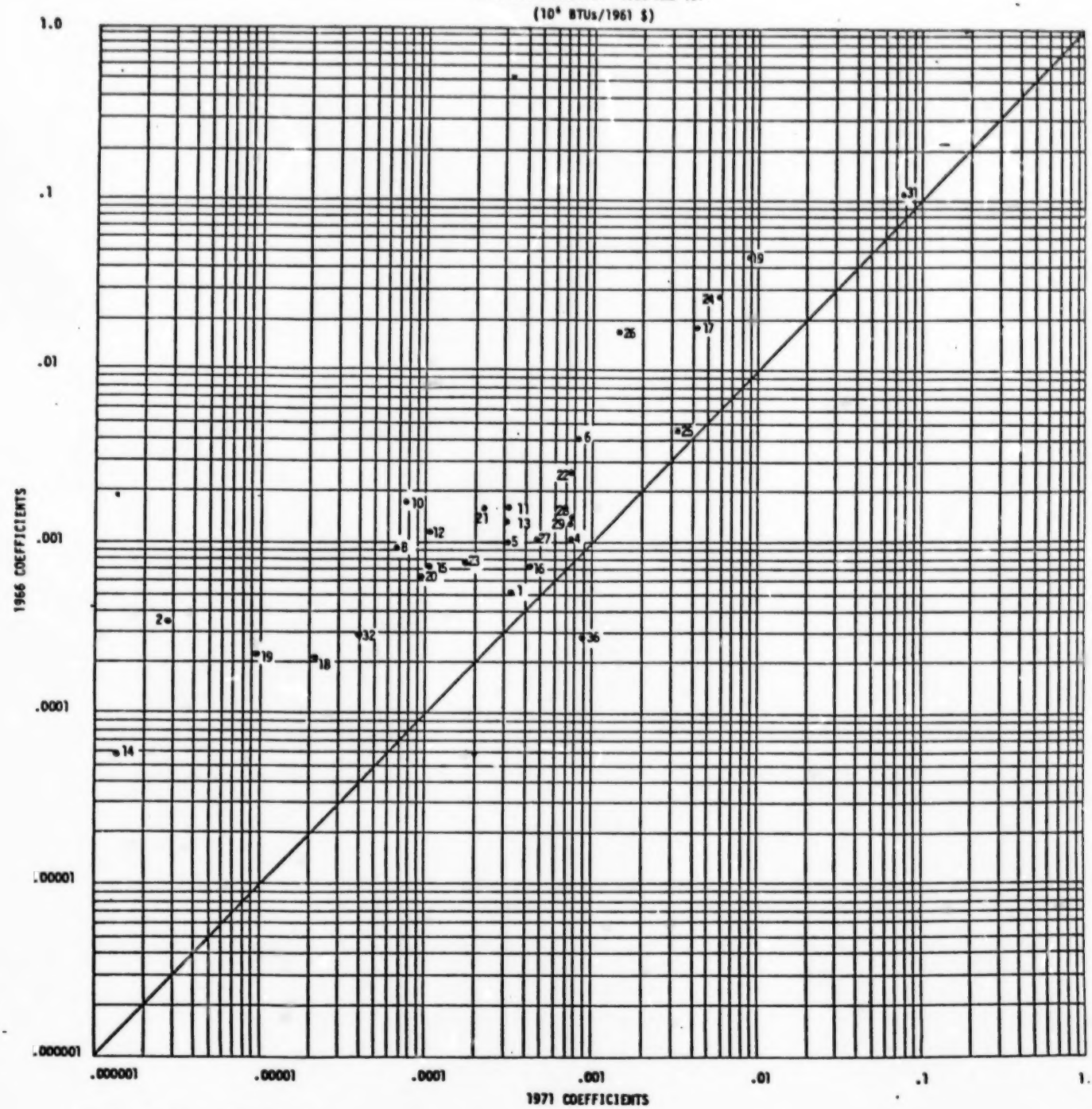



SOURCE: Refer to Tables B.5 and B.6

FIGURE B.5

COAL COEFFICIENTS: 1966 AND 1971

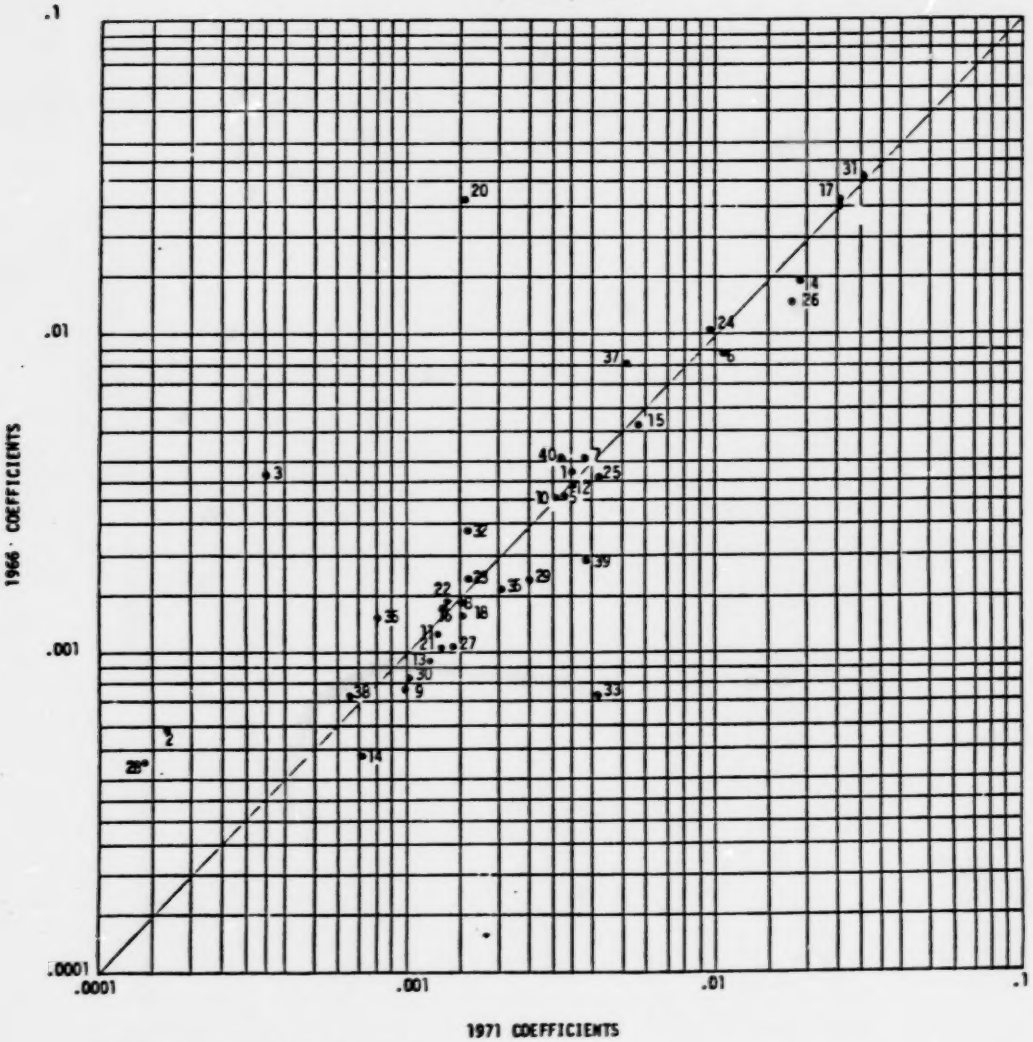
($10^4$ BTUs/1961 $)




SOURCE: Refer to Tables B.5 and B.6

FIGURE B.6

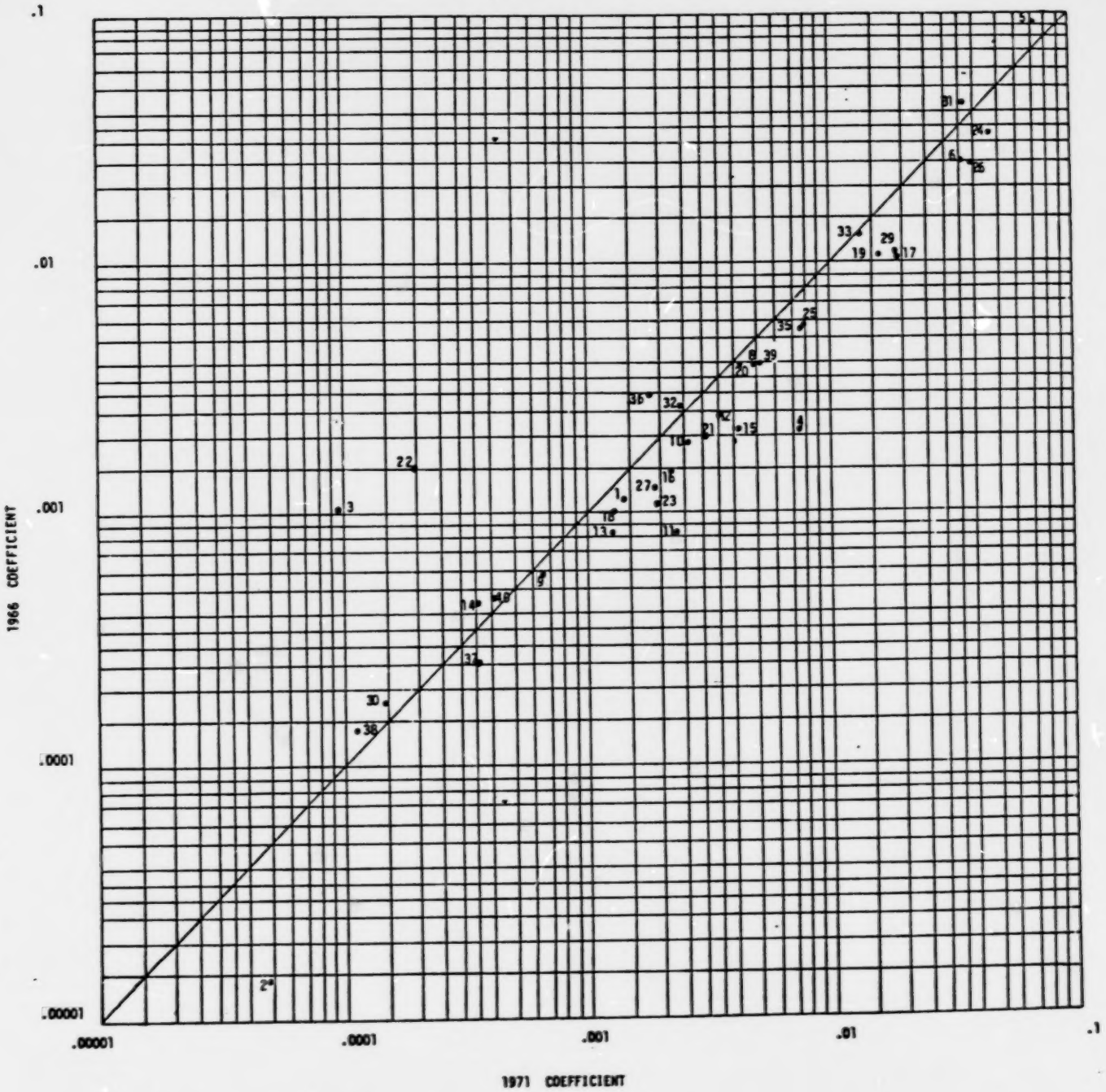
ELECTRICITY COEFFICIENTS: 1966 AND 1971
($10^4$ BTUs/1961 $)




SOURCE: Refer to Tables B.5 and B.6

FIGURE B.7

NATURAL GAS COEFFICIENTS: 1966 AND 1971
($10^4$ BTUs/1961 $)




SOURCE: Refer to Tables B.5 and B.6.

and greater than 1.0 in the other measure (i.e. Btus of energy consumed per unit value of output produced). A first inspection of the graphed[6] direct energy coefficients would also tend to appear to substantiate this initial belief that anomalies existed between the two measures. Each axis of the graph measures the direct energy coefficients for a particular year. When the graphed points fall directly on the 45-degree line this indicates that there has been no shift in energy consumption between 1966 and 1971. Should the points fall above the 45-degree line, then this would indicate that the direct energy coefficients are larger in 1966 than in 1971. Should the coefficients for 1966 be less than those for 1971, then the points would cluster below the 45-degree line.

When graphs incorporating the Btu measures are compared with the graphs incorporating the dollar measures, one finds that some points fall on opposite sides of the 45-degree line. Such measures for individual energy commodities are shown in Figures B.3 to B.7. These differences can also be made by use of the direct energy coefficient ratios:

$$\frac{1971}{1966} \text{ Btu ratio and } \frac{1971}{1966} \text{ \$ ratio}$$

which for these points lie on opposite sides of the number 1.0 (45-degree line). Had one of the ratios exactly equalled 1.0, then this would be equivalent to the graphed coefficient lying directly on the 45-degree line. The anomalies are shown in Figure B.8. This figure presents the coefficient ratios in dollar and Btu measures for all industries. The industry number at the foot of the figure provides a means of identifying the industry. The anomalies lie on opposite sides of the 1.0 line. The largest anomalies are extracted and presented in Tables B.9 and B.10.

Table B.9 contains eighteen industries. These are the industries registering the most substantial differences in direct energy consumption between 1966 and 1971. This is almost half of

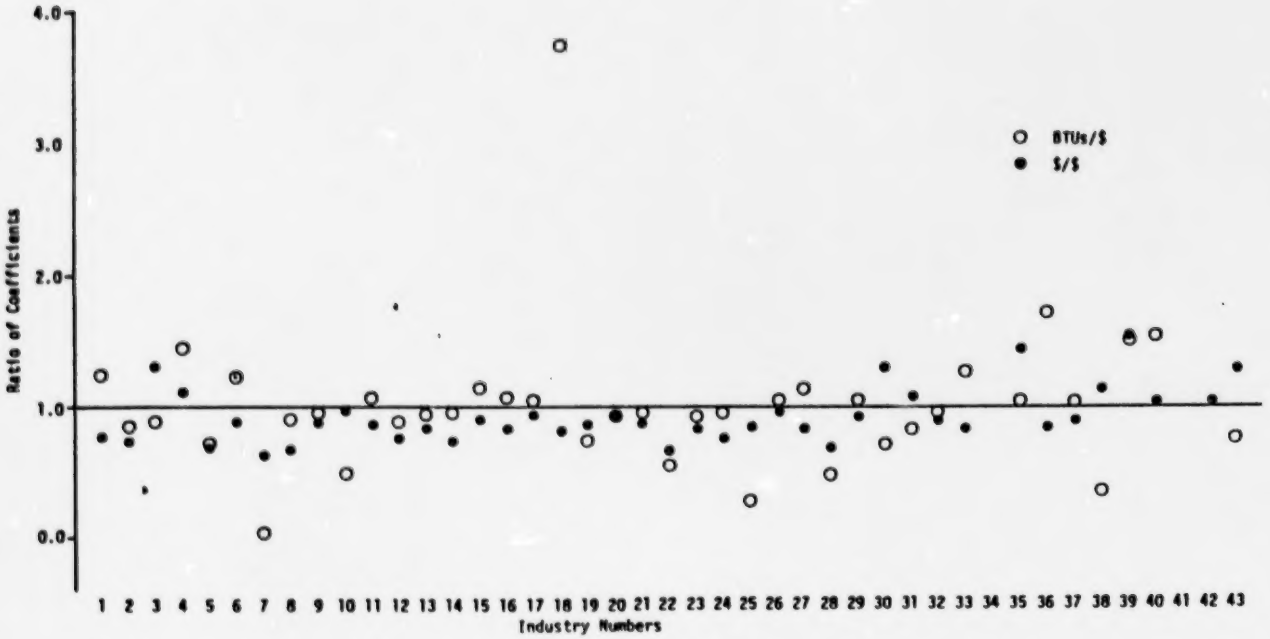



FIGURE 8.8: Direct Energy Coefficients by Industry: BTU and Dollar Coefficients Compared: 1966 and 1971

NOTES: (1) Anomalies lie on opposite sides of line (1.0).
(2) For corresponding industry title to industry number see Table 8.5.

TABLE B.9

VALUE OF TOTAL[a] DIRECT ENERGY COEFFICIENT RATIOS
FOR SELECTED[b] INDUSTRIES: BTU vs DOLLAR MEASURE
(1961 PRICES)

| Industry | 1971 $ Energy Consumption/1971 $ Output / 1966 $ Energy Consumption/1966 $ Output | 1971 BTUs/1971 $ Output[c] / 1966 BTUs/1966 $ Output |
|---|---|---|
| Publishing/Printing | 0.821 | 3.784 |
| Education/Health Serv. | 0.859 | 1.767 |
| Serv. to Business Manage. | 1.163 | 0.394 |
| Communication | 1.314 | 0.769 |
| Travel Promotion/Adv. | 1.271 | 0.789 |
| Retail Trade | 0.861 | 1.281 |
| Fishing/Trapping/Hunting | 1.305 | 0.918 |
| Non-Metal Mines/Quarries | 0.905 | 1.225 |
| Miscellaneous Manuf. | 0.846 | 1.150 |
| Agriculture | 0.965 | 1.265 |
| Elec. Power/Gas/Oth. Ut. | 1.076 | 0.844 |
| Furniture/Fixtures | 0.849 | 1.071 |
| Wood | 0.929 | 1.148 |
| Leather | 0.870 | 1.082 |
| Amusement/Recreation | 0.896 | 1.021 |
| Transportation/Storage | 0.949 | 1.06 |
| Paper/Allied | 0.941 | 1.049 |
| Chemicals/Chemical Prod. | 0.986 | 1.075 |

SOURCE: Refer to Tables B.5, B.6, B.7 and B.8.

NOTES: [a] 'Total' in this context refers to the summation of the individual direct energy coefficients for gasoline and fuel oil, other petroleum and coal products, coal, electricity and natural gas.

[b] These industries were selected on the basis that the value of the ratios must lie on opposite sides of the number 1.0. In graphical terms, these industries' graphed total direct energy coefficients (See Figures B.1 & B.7) lie on opposite sides of the 45-degree line.

[c] These ratios were calculated by taking the values in the last column (Total Energy) for 1971 and dividing through by the corresponding values in the last column for 1966 for each measure.

TABLE B.10

LIST OF INDUSTRIES WITH CONFLICTING CHANGES IN TOTAL DIRECT ENERGY COEFFICIENTS

| Industry | Commodity | % BTU 1966 | % BTU 1971 | % $ 1966 | % $ 1971 |
|---|---|---|---|---|---|
| Publishing & Printing | Gasoline & Fuel Oil | 41.91 | 83.51 | 20.83 | 14.98 |
| | Other Petroleum & Coal Products | .29 | .06 | 9.72 | 10.47 |
| | Coal | 4.76 | .07 | 1.39 | -- |
| | Electricity | 30.18 | 8.91 | 65.28 | 71.48 |
| | Natural Gas | 22.85 | 7.46 | 2.78 | 3.07 |
| Education & Health Services | Gasoline & Fuel Oil | 27.81 | 66.94 | 46.81 | 55.44 |
| | Other Petroleum & Coal Products | 4.27 | 3.68 | 6.38 | 6.37 |
| | Coal | 4.51 | 7.57 | 9.57 | 6.37 |
| | Electricity | 20.67 | 6.98 | 34.04 | 29.05 |
| | Natural Gas | 42.74 | 14.84 | 3.19 | 2.78 |
| Services to Business Management | Gasoline & Fuel Oil | 93.65 | 70.11 | 50.00 | 51.26 |
| | Other Petroleum & Coal Products | 0.23 | 15.66 | 6.25 | 4.39 |
| | Coal | -- | -- | -- | -- |
| | Electricity | 5.11 | 12.22 | 43.75 | 44.35 |
| | Natural Gas | 1.004 | 2.01 | -- | -- |
| Communication | Gasoline & Fuel Oil | 74.94 | 58.27 | 37.29 | 24.63 |
| | Other Petroleum & Coal Products | 1.73 | 3.96 | 6.78 | 4.59 |
| | Coal | -- | -- | -- | -- |
| | Electricity | 19.15 | 33.24 | 55.93 | 70.77 |
| | Natural Gas | 4.17 | 4.53 | -- | -- |
| Travel, Promotion & Advertising | Gasoline & Fuel Oil | 100.0 | 100.0 | 91.27 | 93.68 |
| | Other Petroleum & Coal Products | -- | -- | 8.73 | 6.32 |
| | Coal | -- | -- | -- | -- |
| | Electricity | -- | -- | -- | -- |
| | Natural Gas | -- | -- | -- | -- |
| Retail Trade | Gasoline & Fuel Oil | 38.95 | 34.96 | 21.64 | 27.51 |
| | Other Petroleum & Coal Products | .08 | .11 | 1.22 | 1.55 |
| | Coal | -- | -- | -- | -- |
| | Electricity | 3.37 | 16.29 | 70.88 | 63.64 |
| | Natural Gas | 57.596 | 48.64 | 6.25 | 7.31 |
| Fishing, Trapping & Hunting | Gasoline & Fuel Oil | 98.49 | 98.6 | 83.91 | 84.77 |
| | Other Petroleum & Coal Products | .04 | .09 | 13.79 | 13.32 |
| | Coal | -- | -- | -- | -- |
| | Electricity | .41 | .36 | 2.299 | 1.91 |
| | Natural Gas | 1.05 | .95 | -- | -- |
| Non-Metal Mines & Quarries | Gasoline & Fuel Oil | 35.98 | 34.22 | 37.96 | 37.71 |
| | Other Petroleum & Coal Products | .10 | .31 | 10.65 | 8.47 |
| | Coal | 7.17 | 1.15 | 6.48 | .85 |
| | Electricity | 14.81 | 15.34 | 41.67 | 47.89 |
| | Natural Gas | 41.93 | 48.90 | 3.24 | 5.08 |
| Miscellaneous Manufacturing | Gasoline & Fuel Oil | 40.88 | 41.84 | 21.74 | 17.29 |
| | Other Petroleum & Coal Products | .73 | .72 | 15.94 | 21.30 |
| | Coal | 18.20 | 7.17 | 5.797 | 4.01 |
| | Electricity | 18.78 | 21.998 | 52.17 | 53.39 |
| | Natural Gas | 21.42 | 28.27 | 4.35 | 4.01 |

Continued

TABLE B.10 continued

| Industry | Commodity | % BTU 1966 | % BTU 1971 | % $ 1966 | % $ 1971 |
|---|---|---|---|---|---|
| Agriculture | Gasoline & Fuel Oil | 81.36 | 84.15 | 68.36 | 68.39 |
| | Other Petroleum & Coal Products | 1.45 | 2.48 | 12.32 | 14.16 |
| | Coal | 1.59 | .86 | .53 | .45 |
| | Electricity | 14.78 | 8.84 | 18.44 | 16.65 |
| | Natural Gas | 3.83 | 3.66 | .34 | .35 |
| Electric Power, Gas & Other Utilities | Gasoline & Fuel Oil | 11.92 | 20.60 | 17.61 | 20.35 |
| | Other Petroleum & Coal Products | -- | .02 | .35 | .41 |
| | Coal | 52.85 | 42.38 | 55.05 | 57.84 |
| | Electricity | 14.79 | 16.95 | 23.94 | 18.90 |
| | Natural Gas | 20.44 | 20.04 | 3.05 | 2.498 |
| Furniture & Fixtures | Gasoline & Fuel Oil | 38.99 | 35.296 | 22.73 | 19.08 |
| | Other Petroleum & Coal Products | .31 | .9796 | 2.27 | 4.77 |
| | Coal | 12.63 | 6.33 | 4.55 | 2.31 |
| | Electricity | 23.64 | 21.76 | 68.18 | 69.08 |
| | Natural Gas | 24.43 | 35.63 | 2.27 | 4.77 |
| Wood | Gasoline & Fuel Oil | 39.68 | 35.20 | 30.11 | 20.41 |
| | Other Petroleum & Coal Products | 2.51 | 3.06 | 18.59 | 18.03 |
| | Coal | 4.92 | .63 | .74 | .33 |
| | Electricity | 37.96 | 36.01 | 49.44 | 58.85 |
| | Natural Gas | | | | |
| Leather | Gasoline & Fuel Oil | 45.96 | 49.01 | 22.73 | 26.25 |
| | Other Petroleum & Coal Products | .05 | .09 | 4.54 | 10.54 |
| | Coal | 25.23 | 4.25 | 13.64 | -- |
| | Electricity | 17.08 | 16.28 | 59.01 | 63.21 |
| | Natural Gas | 11.69 | 30.37 | -- | -- |
| Amusement & Recreation | Gasoline & Fuel Oil | 37.86 | 58.93 | 16.09 | 22.66 |
| | Other Petroleum & Coal Products | 1.75 | .49 | 1.15 | 1.04 |
| | Coal | -- | -- | -- | -- |
| | Electricity | 58.56 | 38.07 | 82.76 | 76.29 |
| | Natural Gas | 1.83 | 2.52 | -- | -- |
| Transportation & Storage | Gasoline & Fuel Oil | 78.68 | 66.13 | 80.48 | 80.77 |
| | Other Petroleum & Coal Products | .34 | 2.21 | 5.03 | 5.19 |
| | Coal | 2.10 | 1.06 | 1.49 | .42 |
| | Electricity | 2.61 | 3.54 | 10.20 | 10.59 |
| | Natural Gas | 16.30 | 27.06 | 2.79 | 3.02 |
| Paper & Allied | Gasoline & Fuel Oil | 39.49 | 47.14 | 22.63 | 30.37 |
| | Other Petroleum & Coal Products | .37 | .35 | 8.8 | 8.10 |
| | Coal | 19.42 | 4.64 | 13.14 | 3.39 |
| | Electricity | 29.14 | 27.71 | 53.43 | 54.22 |
| | Natural Gas | 11.59 | 20.16 | 2.01 | 3.91 |
| Chemicals & Chemical Products | Gasoline & Fuel Oil | 15.09 | 16.91 | 7.44 | 7.21 |
| | Other Petroleum & Coal Products | 11.50 | 8.18 | 53.06 | 59.36 |
| | Coal | 22.69 | 1.80 | 10.01 | 1.06 |
| | Electricity | 17.91 | 24.46 | 26.43 | 27.13 |
| | Natural Gas | 32.85 | 48.65 | 3.06 | 5.22 |

SOURCE: See Figures B.1 and B.2.

NOTE: Btus are 'input' Btus.

the number of industries, a proportion which begs the question as to why there are these differences in the two measures. An examination of these measures shows that producing a consistent set of reasons to explain away all the anomalies is difficult. The publishing and printing industry is a good example with which to illustrate this difficulty.

In the printing and publishing industry the ratio of the value of total energy per unit value of output produced (1971/66) was 0.821. In contrast, the ratio of the Btu consumption per unit value of output produced in this industry was 3.784. The latter measure suggests that in the publishing and printing industry production became more energy intensive over the five year period 1966 to 1971, while the former measure suggests that the industry became less energy intensive.

Table B.10 adds to the understanding of these contrary movements by taking, for both measures, the percentage of the total energy use accounted for by each of the five energy commodities. For instance, in the case of the publishing and printing industry, the share of energy measured in Btus accounted for by the gasoline and fuel oil commodity doubled, from 42 percent to 84 percent. In contrast, the share accounted for by electricity fell from 30 percent to below 9 percent. Turning to the dollar measure of energy consumption, it can be seen that the reverse happened in energy commodity shares. The share going to gasoline and fuel oil fell from 21 percent to 15 percent, while electricity's share rose from 65 to 71 percent.

A return to Table B.4 will recall that there appear to have been substantial changes in energy commodity prices. Note the large increase in the price per input Btu of electricity. Gasoline prices showed a much lower price increase. While the substitution of the less expensive gasoline for the more expensive electricity appears to have led to an increased share going to gasoline, as measured in Btus, the price rise in electricity was sufficient for this commodity to more than hold its share of the total revenue spent on energy.

It must also be remembered that the Btu measure used in Tables B.5, B.6 and B.9 are input Btus. It will be recalled also that Table B.1 shows considerable differences in the utilization efficiency factors between electricity and the group of energy commodities which constitute the gasoline and fuel oil group. This table shows that while electricity has a utilization efficiency factor of 100 percent, the energy commodities which constitute the gasoline and fuel oil group range from 20 to 87 percent in the industrial sector. As was discussed earlier, the utilization factor times the input Btu content of the energy commodity produces an estimate of the output Btus. It is the output Btus which interest the manufacturers, and upon which the latters' comparisons will be based.

Returning to the example under analysis, it will be recalled that the energy used, as measured by the dollar value of the energy used appeared to rise, while the reverse happened when using the input Btu measures. If one considers the input Btu measures and relates these to the prices charged for electricity and gasoline and fuel oil then the seeming inconsistency could have a plausible explanation.

A shift from an energy commodity with a high to a lower thermal efficiency is likely to result in a increase in total Btu requirements when input Btu measures are used. In 1971 electricity was priced higher per input Btu than was gasoline and fuel oil. Thus the decreased proportion of energy consumed in the form of electric power resulted in increased (constant) dollar inputs, assuming that the energy bill has not decreased between 1966 and 1971. At the same time, this reduced reliance on electricity is likely to result in an overall increase in the input Btu requirements. If the price of electricity per input Btu rises faster than similarly measured prices of substitute energy commodities then the seemingly contradictory results are likely to be further emphasized.

As this example shows, the use of measures of energy consumption in Btus requires detailed information concerning the rates at which the theoretically calculated Btu content of a commodity (the input Btu) becomes the actual amount that can and is used (the output Btus). Without such information, forming conclusions as to the behaviour of energy use over time with input Btu measures is made difficult.

## B.4 Methodology and Sources for the Energy Data Base

Correspondence with Statistics Canada has suppplied the following information concerning the methodology and sources for the energy data base used in their Btu calculations.

(i) The purpose of the exercise is to arrive at the inputs of energy commodities in natural units to each of the IOIC-W industries.

(ii) Certain classes of industries, notably manufacturing and primary, have 'hard' data on both quantity and value of fuel inputs from Census forms.

(iii) The general mode of operation is not to alter or adulterate any hard data.

(iv) Use of a specific energy commodity by industries for which hard data are not available is obtained by distributing pro rata a residual fuel quantity over the value of fuel inputs to these industries as presented in the 1966 Input-Output accounts.

(v) The residual fuel quantity to be distributed is calculated as the difference between the total intermediate use of the fuel as given in the Detailed Energy Supply and Demand (Statistics Canada Publication 57-505) and the sum of all identified hard figures on consumption.

(vi) In certain instances, as noted in the list of sources which follows, a reconciliation of published figures and Input-Output data has been made.

(vii) The only major deviation from the methodology of (iv) and (v) above occurs in the case of motor gasoline, where the Detailed Energy Supply and Demand does not distinguish intermediate and final use. An average producer's price is used in conjunction with the Input-Output accounts to calculate quantities in industries where hard data are not available, and the residual final use figure checked for credibility against the registrations for passenger automobiles in 1966.

(viii) In the following list of sources, 'Industry' refers to the IOIC-W industries, and references to Divisions or Sections apply to the appropriate bodies within Statistics Canada.

| INDUSTRY | SOURCE |
|---|---|
| Agriculture<br>00100 | Agriculture Division worksheets giving fuel oil and gasoline use in farm machinery by province. Data is an estimate based on the stock of equipment, e.g. tractors and combines, and fuel usage rates from the 1958 farm survey. Estimates of quantity and value are available. |
| Forestry<br>02000 | Statistics Canada Publication 25-201 Logging, Table 11. Since quantity and value data is available in the publication, quantities can be reconciled with the value of inputs appearing in the 1966 Input-Output accounts. |
| Fishing, Hunting & Trapping<br>00300 | Quantities calculated by proration of residual fuel quantities over Input-Output values. |
| Mining<br>00400-00800 | Energy and Mineral Statistics Section worksheets giving purchased fuel and electricity in quantity and value by SIC by province. |
| Coal Mines<br>00900 | In addition to the data from the Energy and Mineral Statistics Section worksheets, coal use within the mine is obtainable from Statistics Canada Publication 57-505, Detailed Energy Supply and Demand. |
| Petroleum & Gas Wells<br>01000 | In addition to the data from the Energy and Mineral Statistics Section worksheets, figures on field, gathering system and processing plant dispostion and use of crude petroleuym and natural gas are available in Statistics Canada publication 26-213, The Crude Petroleum and Natural Gas Industry. |
| Mining<br>01200-01600 | Energy and Mineral Statistics Section worksheets giving purchased fuel and electricity in quantity and value by SIC by province. |

| INDUSTRY | SOURCE |
|---|---|
| Services Incidental Mining 01700 | Quantities calculated by proration of residual fuel quantities over Input-Output values. |
| Manufacturing 01800-08200 | There are two major sources:<br><br>Worksheets of the Energy and Mineral Statistics Section, giving quantity and value of purchased energy by SIC province.<br><br>From 1970 onward, machine readable images of Census of Manufacturing questionnaires at the establishment, as well as at the SIC by province level of aggregation, will be available, from which question no. 5 concerning energy may be read, giving quantities and values.<br><br>In the case of the 1966 data base this information was obtained from a machine readable file of Census of Manufacturing questionnaires by SIC by province prepared for the Regional Input-Output model. |
| Aluminum Smelting & Refining 08310 & Other Smelting & Refining 08320 | Since these two industries represent a split of SIC 2950, data was compiled from establishment level Census of Manufacturing returns, whether in hard copy or machine readable form. |
| Manufacturing 08400 | As above (i.e. other Manufacturing Industries). |
| Petroleum Refineries | In addition to purchased energy from the Census of Manufacturing returns, in-house use of refined products is obtained from Statistics Canada Publication 57-505, Detailed Energy Supply and Demand. |
| Manufacturing 12900-14700 | As above. |

| INDUSTRY | SOURCE |
|---|---|
| Construction 14800 | Quantities calculated by proration of residual fuel quantitites over Input-Output values. |
| Air Transport 14900 | Statistics Canada Publication 51-202, Civil Aviation. |
| Services Incidental to Transport 15000 | Quantities calculated by proration of residual fuel quantities over Input-Output values. |
| Water Transport 15100 | Statistics Canada, Publication 52-205, Water Transport |
| Railway Transport 15200 | Statistics Canada Publication 52-209, Railway Transport: Part III. |
| Truck Transport 15300 | Statistics Canada Publications 53-222, Motor carriers - Freight (Commom and Contract), Part II. |
| | Since Input-Output industry 15300 includes a larger class of trucking than the above publications (in particular it includes intraurban transport), the quantities of fuel from these publications can be increased to reconcile the published value of fuel with the Input-Output value. |
| Bus Transport, Interurban & Rural 15400 | Statistics Canada Publication 53-215, Passenger Bus Statistics. |
| Urban Transit Systems 15500 | Statistics Canada Publication 53-216, Urban Transit. |
| Taxicab Operations 15600 | Quantities calculated by proration of residual fuel quantities over Input-Output values. |
| Pipeline Transport 15700 | Statistics Canada Publications 55-201, Oil Pipeline Transport and 57-205, Gas Utilities. |

| INDUSTRY | SOURCE |
|---|---|
| Highway Maintenance, Storage, Communic. | Quantities calculated by proration of residual fuel quantities over 15800-16200 Input-Output values. |
| Electric Power 16300 | Line losses from Statistics Canada Publication 57-505, Detailed Energy Supply and Demand. Fuel used in thermal generation from Statistics Canada Publication 57-202, Electric power Statistics Volume II. |
| Gas Distribution 16400 | Statistics Canada publication 57-205, Gas Utilities. |
| Services & Miscellaneous 16500-19100 | Quantities calculated by proration of residual fuel quantities over Input-Output values. |

## FOOTNOTES - APPENDIX B

[1]Refer to Appendix A for further discussion and classification of the term "producers' prices".

[2]See Schurr, Sam. Netschert, Bruce. [44].

[3]Statistics Canada, Catalogue No. 57-505, [25], p. 3.

[4]Statistics Canada, Catalogue Nos. 57-002 [32] and 57-506 [24].

[5]For a more detailed discussion of the method used to calculate these ratios refer to the notes proceeding Table B.9.

[6]Refer to Figures B.1 and B.2. Total energy coefficients: 1966 graphed against 1971 in both the BTU and dollar measures.

## APPENDIX C

## CONVERSION OF DIRECT ENERGY COMMODITIES INTO DIRECT PRIME ENERGY COMMODITIES

It will be recalled that in Appendix B the Structural Analysis Branch of Statistics Canada provided details of the direct energy consumed (according to the M aggregation) measured in Btus. The energy commodities were broken down in such a way that the prime energy commodities could be separated from the secondary energy commodities. By separating out the prime energy commodities a basis of comparison could then be made with the data, also sent from the Structural Analysis Branch of Statistics Canada, which was of the total prime energy consumed by industry. These latter data were also in Btus, the year being 1966. See Table C.1 for details.

Before going on to describe the treatment given to the direct demand estimates to make them comparable with the total demand estimates there is a need to examine the definition of prime energy. The commodities included in the title 'prime energy of the total demand estimates' differ from those included in Chapter 2.2 The most significant difference is that refined petroleum products are not 'taken back' to crude oil, and instead are included among the prime energy commodities.

The two secondary energy commodities to be converted into prime energy are coke and thermal electricity. Coke is 'converted' back into its coal equivalence by using the conversion rate of 0.75. Note that the recorded consumption of coke in the iron and steel industry is excluded, for this would involve double counting. In the case of electricity, the most difficult problem involves determining the proportion of electricity purchased by industry

which is 'thermal electricity' (See Table C.1). Using average estimates for 1966, the proportion of purchased electricity which is assumed to be thermal is 0.1915 (and hydro 0.8085). The thermal electricity figure is then converted into primary energy by multiplying by 0.3. It is assumed that one Btu of hydroelectricity is equivalent to one Btu of primary energy, so that the 'converted' thermal electricity is thus added to the Btus of hydroelectricity to form the primary energy measure for purchased electricity. Finally, there is the problem of converting the secondary energy used by the 'Electric Power, Gas and Other Utilities' into primary energy. In order to prevent double counting only purchased electricity is counted, and then it is converted into 'primary electricity' by means of the method described above.

# TABLE C.1

SOURCE: Structural Analysis Division, Statistics Canada.

**TABLE C.1 (Cont'd)**

ENERGY DATA - 15 ENERGY TYPES IN MILLIONS OF BTUS MAY, 1978

| | CANADIAN BITUMINOUS COAL | IMPORTED BITUMINOUS COAL | SUB-BITUMINOUS COAL | ANTHRACITE COAL | LIGNITE COAL | COKE | GASOLINE | FUEL OIL |
|---|---|---|---|---|---|---|---|---|
| 1 AGRICULTURE | 782700 | 1784196 | 0 | 0 | 0 | 0 | 58810786 | 461 18912 |
| 2 FORESTRY | 177781 | 0 | 0 | 0 | 0 | 0 | 4187009 | 1274 2007 |
| 3 FISHING, HUNTING & TRAPPING | 0 | 0 | 0 | 0 | 0 | 38648 | 9704465 | 9177193 |
| 4 METAL MINES | 181941 | 134779 | 0 | 2251 | 2210 | 81741 | 5704414 | 2 1115800 |
| 5 MINERAL FUELS | 1467117 | 0 | 0 | 0 | 0 | 4834 | 2800806 | 1844085 |
| 6 NON-METAL MINES & QUARRIES | 348096 | 175821 | 0 | 0 | 250734 | 75 | 6513561 | 47 01147 |
| 7 SERVICES INCIDENTAL TO MINING | 0 | 0 | 0 | 0 | 0 | 0 | 2318993 | 1140 7001 |
| 8 FOOD & BEVERAGE INDUSTRIES | 1121115 | 4952565 | 49980 | 1 10658 | 9005 | 19192 | 105844456 | 17 6484 48 |
| 9 TOBACCO PRODUCTS INDUSTRIES | 1960 | 82760 | 0 | 843 | 0 | 0 | 23687 | 7707 58 |
| 10 RUBBER & PLASTICS PRODUCTS IND. | 9450 | 1455996 | 22542 | 0 | 0 | 0 | 1082751 | 5271665 |
| 11 LEATHER INDUSTRIES | 84119 | 498217 | 0 | 1143 | 0 | 0 | 167707 | 1071341 |
| 12 TEXTILE INDUSTRIES | 356887 | 1174647 | 0 | 11049 | 0 | 0 | 1491121 | 14819285 |
| 13 KNITTING MILLS | 153811 | 777757 | 0 | 27264 | 0 | 0 | 741164 | 12 01 380 |
| 14 CLOTHING INDUSTRIES | 24797 | 31502 | 0 | 1982 | 0 | 4816 | 1818 37 | 427 4683 |
| 15 WOOD INDUSTRIES | 814725 | 111301 | 5218 | 8788 | 8118 | 645 | 7153865 | 5047610 |
| 16 FURNITURE & FIXTURE INDUSTRIES | 176832 | 265150 | 18415 | 1544 | 3115 | 1172 | 2972265 | 1813205 |
| 17 PAPER & ALLIED INDUSTRIES | 2648 1397 | 9 1136 348 | 8 2 0037 | 0 | 43 80425 | 164019 | 5209261 | 10 0 0 2 0 9 6 |
| 18 PRINTING & PUBLISHING | 152284 | 52942 | 21811 | 9309 | 0 | 1240 | 4491156 | 1595512 |
| 19 PRIMARY METAL INDUSTRIES | 17 3 13024 | 14 67 8 4944 | 170 | 41 77257 | 2944 15 | 111 48 8208 | 5528621 | 44 827016 |
| 20 METAL FABRICATING INDUSTRIES | 612864 | 1041757 | 3027 | 4054 1 | 2125 | 126600 | 17882U | 1422623 |
| 21 MACHINERY INDUSTRIES | 1 0 0 2562 | 1 0 1 7 8 9 | 8 2 4 5 | 4 8 1 4 7 | 3534 | 1 1 4 8 0 9 | 3328522 | 2847748 |
| 22 TRANSPORTATION EQUIPMENT IND. | 5388151 | 8892584 | 5168 | 194919 | 5051 | 10790 | 10041552 | 8021845 |
| 23 ELECTRICAL PRODUCTS INDUSTRIES | 56574 | 1727670 | 0 | 0 | 5051 | 267906 | 5154881 | 515 6881 |
| 24 NON-METALLIC MINERAL PROD. IND. | 947741 0 | 1 9 8 4 4 7 5 2 | 661 | 21539 | 15 8 19 4 | 361137 | 7019184 | 2276 4528 |
| 25 PETROLEUM & COAL PRODUCTS IND. | 6 3 8 5 0 9 9 | 8166 | 13 3 9 4 | 1307 | 1 3 7 1 4 3 4 | 0 | 7 6 9 5 1 8 | 37 84 4552 |
| 26 CHEMICAL & CHEMICAL PROD. IND. | 7 9 0 4 8 4 3 1 | 13 5 5 1 9 5 2 | 0 | 20 6 9 8 5 | 15 7 0 8 1 2 | 4 7 9 1 7 1 N | 6 8 8 1 1 2 | 947 0 8 8 9 0 |
| 27 MISC. MANUFACTURING INDUSTRIES | 4 5 6 2 2 1 | 1 5 7 5 8 8 | 1141 | 29144 | 0 | 20460 | 405947 | 14 8 2 0 1 4 |
| 28 CONSTRUCTION INDUSTRY | 4 0 7 6 7 1 4 | 8 1 7 0 2 0 1 | 0 | 0 | 0 | 0 | 6 1 6 2 1 1 6 | 2 0 5 8 6 0 1 2 |
| 29 TRANSPORTATION & STORAGE | 7 1 4 9 1 3 0 | 0 | 0 | 0 | 0 | 0 | 1 3 6 1 9 0 2 | 3 8 2 1 0 4 1 |
| 30 COMMUNICATION | 0 | 0 | 0 | 0 | 0 | 0 | 1 4 7 2 0 9 5 | 1 5 4 4 9 2 8 |
| 31 ELEC. POWER GAS, OTHER UTILITIES | 41 8 10 1 6 8 | 8 7 9 7 9 5 8 8 | 29 3 3 1 9 5 2 | 0 | 14 3 1 8 7 5 2 | 0 | 2 6 7 8 1 5 0 4 | 3 2 0 1 1 2 1 2 |
| 32 WHOLESALE TRADE | 4 1 8 0 9 1 | 6 8 8 2 2 8 | 0 | 0 | 0 | 0 | 2 4 0 2 0 0 0 | 2 2 0 4 3 7 0 4 |
| 33 RETAIL TRADE | 0 | 0 | 0 | 0 | 0 | 0 | 2 9 1 5 7 9 1 | 1 4 8 4 2 1 9 9 |
| 34 OTHER FINANCE, INS. & REAL ESTATE | 0 | 0 | 0 | 0 | 0 | 0 | 1 5 4 1 2 1 0 | 8 8 1 7 0 8 7 |
| 35 EDUCATION & HEALTH SERVICES | 6 3 7 9 1 7 | 1 0 4 5 0 8 0 | 0 | 0 | 0 | 0 | 1 8 1 6 5 7 | 4 5 1 0 4 4 1 |
| 36 AMUSEMENT & RECREATION SERVICES | 0 | 0 | 0 | 0 | 0 | 0 | 2 5 4 1 9 5 | 2 1 5 4 1 7 4 |
| 37 SERVICES TO BUSINESS MANAGEMENT | 0 | 0 | 0 | 0 | 0 | 0 | 1 1 7 8 3 1 | 2 0 2 8 2 0 8 |
| 38 ACCOMMODATION & FOOD SERVICES | 0 | 0 | 0 | 0 | 0 | 0 | 1 9 1 8 2 6 4 | 1 7 1 9 8 1 6 |
| 39 OTHER PERSONAL & MISC SERVICES | 0 | 0 | 0 | 0 | 0 | 0 | 2 3 5 5 0 8 4 8 | 0 |
| 40 TRAVEL & ADVERTISING, PRODUCTION | 0 | 0 | 0 | 0 | 0 | 0 | | |
| TOTAL | 12 8 7 3 1 1 8 4 | 3 4 5 8 2 6 4 5 1 | 2 9 9 0 6 0 6 8 | 5 1 2 7 4 9 3 | 2 9 3 8 3 4 8 7 | 1 1 9 1 4 5 9 1 2 | 1 3 4 4 1 2 6 3 9 | 9 4 2 2 7 7 1 1 3 |

# APPENDIX D

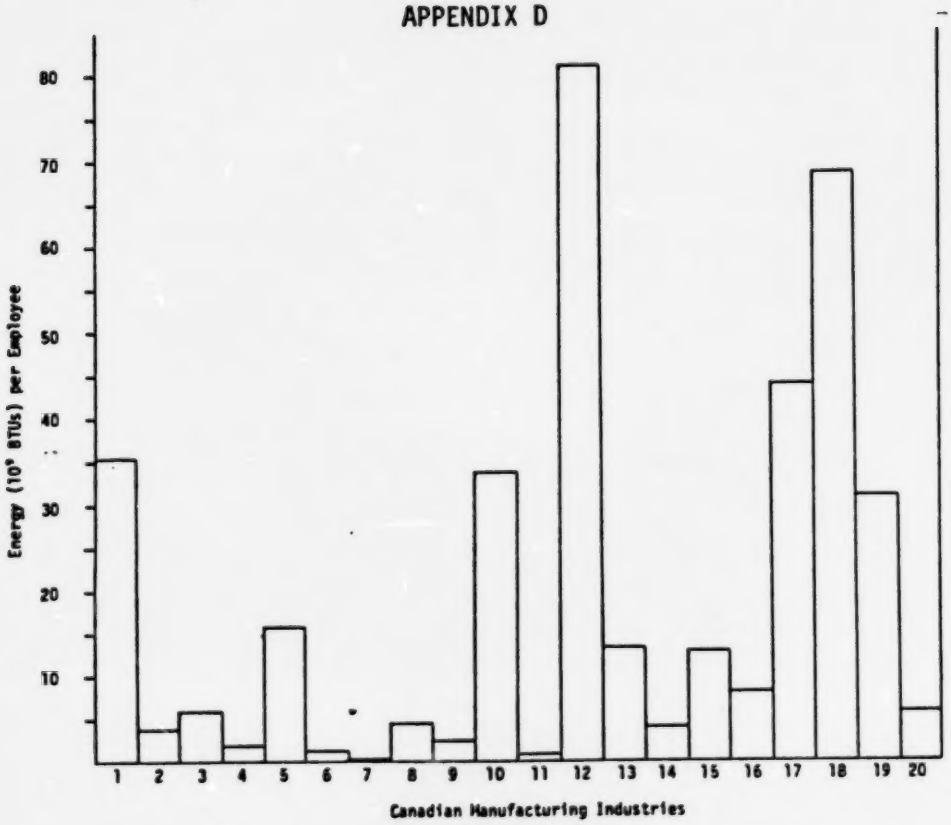



FIGURE D.1: Total Energy to Direct Labour Content Ratios of Canadian Manufacturing Industries in 1966: BTUs and Number of Employees

1. Food & Beverage
2. Tobacco Products
3. Rubber & Plastic Products
4. Leather
5. Textiles
6. Knitting Mills
7. Clothing
8. Wood
9. Furniture & Fixture
10. Paper & Allied
11. Printing Publishing & Allied
12. Primary Metal
13. Metal Fabricating
14. Machinery
15. Transport Equipment
16. Electrical Products
17. Non-metallic Mineral Products
18. Petroleum & Coal Products
19. Chemicals & Chemical Products
20. Miscellaneous Manufacturing

SOURCE: See Table D.1

TABLE D.1

TOTAL ENERGY TO LABOUR CONTENT RATIOS
OF CANADIAN MANUFACTURING INDUSTRIES IN 1966:
BTUs & NOS. EMPLOYED

| | Industry | $10^9$ BTUs Consumed | Employees | $10^9$ BTUs/Employee Consumed |
|---|---|---|---|---|
| 1. | Food & Beverage | 7824162.88 | 227221 | 34.434 |
| 2. | Tobacco Products | 41128.71 | 10177 | 4.041 |
| 3. | Rubber & Plastic Prod. | 169030.95 | 27821 | 6.076 |
| 4. | Leather | 73024.90 | 32667 | 2.235 |
| 5. | Textile | 1233989.19 | 77248 | 15.974 |
| 6. | Knitting Mills | 33536.80 | 23609 | 1.421 |
| 7. | Clothing | 47355.84 | 99708 | 0.475 |
| 8. | Wood | 432976.8 | 91937 | 4.709 |
| 9. | Furniture & Fixtures | 113091.81 | 43598 | 2.594 |
| 10. | Paper & Allied | 3945037.25 | 116840 | 33.764 |
| 11. | Printing Publishing & Allied | 86490.09 | 81996 | 1.055 |
| 12. | Primary Metal | 9234766.80 | 113645 | 81.260 |
| 13. | Metal Fabricating | 1928966.00 | 143311 | 13.460 |
| 14. | Machinery | 357858.51 | 75451 | 4.743 |
| 15. | Transport Equipment | 1913574.36 | 146932 | 13.024 |
| 16. | Electrical Products | 1035127.76 | 124498 | 8.134 |
| 17. | Non-metallic Mineral Products | 2347003.03 | 53189 | 44.126 |
| 18. | Petroleum & Coal Prod. | 1060291.58 | 15403 | 68.837 |
| 19. | Chemical & Chemical Prod. | 2275174.50 | 73317 | 31.032 |
| 20. | Misc. Manufacturing | 400261.62 | 67534 | 5.927 |
| ALL MANUFACTURING INDUSTRIES | | | 1646102 | |

SOURCES: The number of employees taken from Statistics Canada Catalogue No. 31-203P [22] Table 2
The BTU estimates (BTUs/$) by industry were obtained from information given by the Structural Analysis Division, Statistics Canada.
The values of industry outputs used to calculate BTU figures were taken from Statistics Canada Catalogue No. 15-506E Occasional [30] Table 46.

TABLE D.2

CANADIAN ELECTRICITY GENERATION DATA 1975.
PUBLICLY AND PRIVATELY OPERATED UTILITIES.
GENERATION RESOURCE OR FUEL AS A PERCENTAGE OF TOTAL GENERATION.

| | Canada | Newfound-land | Prince Edward Island | Nova Scotia | New Brunswick | Quebec | Ontario | Manitoba | Saskatchewan | Alberta | British Columbia | Yukon & NWT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | 72.6 | 98.8 | -- | 11.5 | 51.7 | 99.8 | 49.1 | 97.2 | 38.3 | 9.9 | 91.2 | 71.7 |
| Uranium | 5.0 | -- | -- | -- | -- | -- | 15.8 | -- | -- | -- | -- | -- |
| Canadian Bituminous Coal | 0.9 | -- | -- | 20.3 | 10.5 | -- | 0.2 | -- | -- | 1.9 | -- | -- |
| U.S. Bituminous Coal | 8.3 | -- | -- | -- | -- | -- | 26.5 | -- | -- | -- | -- | -- |
| Sub-Bituminous Coal | 3.7 | -- | -- | -- | -- | -- | -- | -- | 7.6 | 57.6 | -- | -- |
| Lignite Coal | 1.5 | -- | -- | -- | -- | -- | 0.0 | 2.4 | 46.5 | -- | -- | -- |
| Light Fuel Oil | 0.1 | -- | -- | 0.4 | -- | -- | 0.2 | 0.0 | -- | -- | 0.0 | -- |
| Heavy Fuel Oil | 2.6 | 0.9 | 89.3 | 67.6 | 37.5 | 0.0 | 0.6 | -- | 0.4 | 0.1 | 0.1 | 1.5 |
| Diesel Fuel Oil | 0.3 | 0.4 | 10.7 | 0.2 | 0.3 | 0.2 | 0.0 | 0.3 | 0.1 | 0.1 | 0.6 | 26.8 |
| Other Fuel Oil | 0.0* | -- | -- | -- | -- | -- | -- | 0.0 | -- | -- | 0.1 | -- |
| Natural Gas | 5.1 | -- | -- | -- | -- | -- | 7.1 | 0.0 | 7.1 | 30.4 | 8.3 | --- |

NOTES: *Manitoba jet-fuel, B.C. crude oil, 0.0% indicates that there is a value but it is less than .05% of the total amount for the nation or province.

Columns may not add to 100 due to rounding.

SOURCE:

Taken from G. Protti [17], Table 1.2, page 4.

TABLE D.3

PRICE INDICES OF FACTOR INPUTS USED BY ONTARIO MANUFACTURING INDUSTRIES;
ENERGY, CAPITAL AND LABOUR INDICES 1962 TO 1974
1962 = 100.0 (CONSTANT 1962 DOLLARS)

| Year | Energy Index [a] | Capital Index [b] | Labour Index [c] |
|---|---|---|---|
| 1962 | 100.0 | 100.0 | 100.0 |
| 1963 | 98.95 | 101.6 | 102.3 |
| 1964 | 97.33 | 104.5 | 104.5 |
| 1965 | 97.3 | 107.9 | 107.5 |
| 1966 | 96.1 | 108.5 | 109.0 |
| 1967 | 95.4 | 104.4 | 111.3 |
| 1968 | 94.9 | 99.6 | 115.7 |
| 1969 | 95.6 | 99.6 | 119.1 |
| 1970 | 96.5 | 100.5 | 123.7 |
| 1971 | 100.3 | 101.4 | 129.1 |
| 1972 | 97.8 | 100.9 | 132.6 |
| 1973 | 98.3 | 99.7 | 133.7 |
| 1974 | 103.5 | 103.6 | 134.2 |

SOURCES: Statistics Canada, 'Energy Statistics: Service Bulletin', Catalogue No. 57-002 [32] Vol. II, No. 29.

Statistics Canada, Census of Manufacturing, General Review of the Manufacturing Industries in Canada: National and Provincial Areas', Catalogue No. 31-203, [27] provided the basis of calculations carried out by R.N. McRae and A.R. Webster, [16].

Canadian Petroleum Association Statistical Yearbook 1975, page 71 and 1976.

NOTES: [a] The energy index was calculated using quantity figures in natural units (i.e. thousands of gallons, kWh, barrels, cubic feet) for different fuel types consumed by Ontario Manufacturing industries and their respective dollar values. These statistics were derived from the Statistics Canada publication 'Energy Statistics: Service Bulletin', Catalogue No. 57-002 [32] Vol. II, No. 29. The statistics in the fuel category 'Other Fuels, NES' were not utilized however, since the dollar values were published and not the quantity figures. The quantity figures in natural units were converted first to 'input' BTUs with the aid of Table B.2, entitled 'Energy Commodities: Natural Units and Their Input BTU Conversion Factors' and then secondly into 'output' BTUs using the industrial 'Energy Utilization Efficiency Factors' presented in Table B.1. One should note at this point that using the 'Industrial' utilization efficiency factors may introduce a bias to the results since manufacturing is only one component of the industrial sector. Once these conversions to 'output' BTUs had been completed across fuel types in each year (1962 to 1974 inclusive) the total 'output' BTUs consumed in each year was calculated. This involved aggregating individual 'output' BTUs values for each fuel type to arrive at an aggregate for the particular year concerned. The dollar figures were also aggregated for each fuel type consumed in Ontario Manufacturing to arrive at the total dollars spent on energy in any particular year (1962-1974 inclusive). The total dollar figures were at this point recorded in 'current dollars', therefore, to deflate these dollar figures and present the total dollars in 'real' terms they were adjusted using the Consumer Price Index presented in Table 1.2 where 1962 was used as the base year. The deflated (real) dollar totals were divided through by the corresponding output BTU figures to express the measure 'dollars per output BTU'. These 'dollars per output BTU' measures were then indexed using 1962 as the base year equal to 100.0.

[b] The capital index measures deflated dollar values of the capital stock used in the Ontario manufacturing industry. This series was obtained by taking the current value of the capital stock and dividing by a constant dollar value, 1962=100.0. The data used in deriving this index was provided by the Economic Council of Canada, Regional Data Bank of Annual Time Series for Manufacturing. The index used in the deflation was not available. The resultant series was then deflated with the Consumer Price Index.

[c] The labour index provides a measure of the dollars spent on salaries and wages per employee. It was derived using Statistics Canada, Census of Manufacturing Data, Catalogue No. 31-203 [27]. Use was made of the 'total activity' values as defined by Statistics Canada for the number of employees and value of salaries and wages paid out. The resultant series was then deflated with the Consumer Price Index.

TABLE D.4

PRICE INDICES OF CAPITAL EXPENDITURE IN ONTARIO AND CANADIAN MANUFACTURING INDUSTRIES: 1962 TO 1974

| Year | 1962 = 100.0 Capital Index for Ontario[a] | 1971 = 100.0 Capital Index I for Canada[b] | 1971 = 100.0 Capital Index II for Canada[c] |
|---|---|---|---|
| 1962 | 100.0 | 68.4 | 79.6 |
| 1963 | 103.3 | 70.3 | 81.8 |
| 1964 | 108.2 | 72.2 | 85.1 |
| 1965 | 114.4 | 76.2 | 88.4 |
| 1966 | 119.4 | 80.8 | 91.2 |
| 1967 | 118.9 | 84.1 | 90.7 |
| 1968 | 118.1 | 84.9 | 90.8 |
| 1969 | 123.4 | 89.6 | 92.9 |
| 1970 | 128.8 | 94.2 | 97.4 |
| 1971 | 133.7 | 100.0 | 100.0 |
| 1972 | 139.3 | 105.7 | 102.6 |
| 1973 | 148.0 | 114.3 | 106.9 |
| 1974 | 170.7 | 133.1 | 121.4 |

SOURCES: For a list of the sources used in deriving the capital index for Ontario, refer to Note 2 attached to Table D.3. The series shown here is not deflated by the Consumer Price Index.

Indices I and II were obtained from Statistics Canada, National Income and Expenditure Accounts 1962-1976, Catalogue No. 13-201, Annual [31], Table 7, pp. 8 & 9.

NOTES: [a]This index is applicable only to the province of Ontario. Capital in this context includes an aggregate sum of both non-residential construction, and machinery and equipment. The base year for this index is 1962.

[b]Capital indices I and II are currently weighted price indices for Canada. They reflect pure price changes and also changing expenditure patterns within and between non-residential construction and machinery and equipment. They were derived by dividing the total in current dollars by the total in constant dollars. The index used in deflating the current dollars to constant dollars has not been made available. Capital index I is an index of gross national expenditure on non-residential construction. The base year used in this index was 1971.

[c]Capital index II is an index of gross national expenditure on machinery and equipment. The year 1971 was also used as the base year in calculating the index.

TABLE D.5

THE RANKING OF COMMODITIES ACCORDING TO THEIR TOTAL IMPACTS: 1971 'S' AGGREGATION

| Rank(1) | Commodity Number | Commodity | Total Impact on All Industries Total | Arith. Mean | Total Intermediate Output(2) $M | Trade Balance(3) $M |
|---|---|---|---|---|---|---|
| 1 | 41 | Transportation Margins | 2.5513 | 0.1595 | 1827.8 | - |
| 2 | 43 | Travel, Advert., Promotion | 2.3029 | 0.1439 | 2931.2 | - |
| 3 | 42 | Operating, Office, Lab & Food | 2.2417 | 0.1401 | 4970.1 | - |
| 4 | 11 | Beverages | 1.9608 | 0.1226 | 129.8 | 47.1 |
| 4 | 20 | Primary Metal Products | 1.9608 | 0.1226 | 3656.4 | 1262.9 |
| 5 | 15 | Knitted Prod. & Clothing | 1.9607 | 0.1225 | 204.0 | -213.1 |
| 5 | 18 | Paper and Paper Products | 1.9607 | 0.1225 | 2205.5 | 1700.8 |
| 6 | 12 | Tobacco & Tobacco Products | 1.9606 | 0.1225 | 125.5 | 40.4 |
| 7 | 19 | Printing & Publishing | 1.9604 | 0.1225 | 1364.1 | -250.0 |
| 8 | 16 | Lumber, Sawmill, Other Wood Prod. | 1.9603 | 0.1225 | 1468.4 | 222.3 |
| 9 | 21 | Metal Fabricated Products | 1.9599 | 0.1225 | 3545.1 | -446.8 |
| 10 | 25 | Non-Metallic Mineral Prod. | 1.9593 | 0.1225 | 1516.1 | -134.5 |
| 11 | 23 | Autos, Truck, Other Trans. Equip. | 1.9592 | 0.1225 | 3276.3 | -132.7 |
| 11 | 13 | Rubber, Leather, Plastic Fab. Prod. | 1.9592 | 0.1225 | 1135.1 | -402.8 |
| 12 | 17 | Furniture & Fixtures | 1.9588 | 0.1224 | 58.8 | -18.0 |
| 13 | 22 | Machinery & Equipment | 1.9586 | 0.1224 | 1543.9 | -1612.3 |
| 14 | 14 | Textile Products | 1.9582 | 0.1224 | 1819.3 | -631.4 |
| 15 | 10 | Fruit, Veg., Feed, Misc. Food Prod. | 1.9578 | 0.1224 | 1523.4 | -182.8 |
| 16 | 26 | Petroleum & Coal Products | 1.9525 | 0.1220 | 1356.5 | -152.3 |
| 17 | 28 | Misc. Manuf. Products | 1.9488 | 0.1218 | 792.9 | -770.1 |
| 18 | 27 | Chemicals, Chemical Products | 1.9460 | 0.1216 | 2442.0 | -361.0 |
| 19 | 24 | Elec. & Communications Prod. | 1.9101 | 0.1213 | 1804.9 | -750.3 |
| 20 | 9 | Meat, Fish & Dairy Products | 1.9312 | 0.1207 | 1409.5 | 257.5 |
| 21 | 3 | Forestry Products | 1.8517 | 0.1157 | 1304.3 | -7.2 |
| 22 | 29 | Residential Construction | 1.8041 | 0.1126 | - | - |
| 22 | 30 | Non-Residential Construction | 1.8041 | 0.1126 | - | - |
| 22 | 31 | Repair Construction | 1.8041 | 0.1126 | 2022.5 | - |
| 23 | 2 | Other Agriculture Products | 1.7338 | 0.1084 | 3023.0 | -50.8 |
| 24 | 1 | Grains | 1.7331 | 0.1083 | 363.9 | 772.9 |
| 25 | 5 | Metallic Ores & Concentrates | 1.6451 | 0.1028 | 1434.1 | 707.6 |
| 26 | 7 | Non-Metallic Minerals | 1.6342 | 0.1021 | 283.9 | 166.4 |
| 27 | 6 | Mineral Fuels | 1.6217 | 0.1014 | 1774.6 | 72.2 |
| 28 | 8 | Services Incidental to Mining | 1.6213 | 0.1013 | 307.6 | - |
| 29 | 32 | Transportation & Storage | 1.5979 | 0.0999 | 5831.4 | 534.8 |
| 30 | 35 | Wholesale Margins | 1.5937 | 0.0996 | 3365.4 | 658.8 |
| 31 | 39 | Business Services | 1.5476 | 0.0967 | 2463.9 | -311.4 |
| 32 | 40 | Personal & Other Misc. Services | 1.5453 | 0.0966 | 3128.5 | -15.4 |
| 33 | 36 | Retail Margins | 1.4891 | 0.0931 | 799.1 | - |
| 34 | 4 | Fishing & Trapping Products | 1.4254 | 0.0891 | 187.8 | 16.8 |
| 35 | 38 | Other Finance, Ins., Real Estate | 1.3969 | 0.0873 | 4676.2 | -210.7 |
| 36 | 37 | Imputed Rent, Owner Occupied Dwellings | 1.3969 | 0.0873 | - | - |
| 37 | 33 | Communication Services | 1.3436 | 0.0840 | 1466.1 | 2.5 |
| 38 | 34 | Other Utilities | 1.3065 | 0.0817 | 1158.9 | 35.0 |

SOURCE: S.C. Cat. 15-506E[30] Tables 83 and 84.

NOTES: (1) Ranked according to the size of the total impact.
(2) This is included to give some idea of the relative size of the commodity.
(3) This column is included to give some idea of the size of the trade in the commodity. Trade balance equals domestic exports plus re-exports minus imports.

TABLE D.6

COMPARISON OF SELECTED QUEBEC AND CANADIAN INDUSTRY CLASSIFICATIONS

| QUEBEC Industrial Classification | CANADIAN Industrial Classification |
|---|---|
| Petroleum Prod. Ind. | Petroleum Refineries |
| Public Transit | Urban Transit |
| Cement/Concrete Ind. | Cement Mfgrs. |
| Personal Services | Other Personal Serv. |
| Non-Metal Mines | Other Non-Metal Mines |
| Meat Industries | Slaughtering/Meet Proc. |
| Postal Services | Post Office |
| Paper Prod. Ind. | Paper Box/Bag Mfg. |
| Hotels & Restaurants | Accom. & Food Services |
| Metal Mines | Base Metal/Oth. Metal Mines |

The industrial classification schemes in the Quebec and Canadian models differed to some degree. The preceeding list outlines where some of these differences occurred and presents the Canadian industries which were used as proxies for the Quebec industries.

TABLE D.7

COMPARISON OF SELECTED QUEBEC AND CANADIAN COMMODITY CLASSIFICATIONS

| QUEBEC Commodity Classification | CANADIAN Commodity Classification |
|---|---|
| Crude Oil | Crude Mineral Oils |
| Natural Gas Derivatives | Butane/Propane/Other LPG |
| Oils/Greases/Lubricants | Lubricant Oils/Greases |
| Storage: Grain Elevators | Storage |
| Trans/Storage Margins | Transportation Margins |
| Serv. Inc. to Agric. | Serv. Inc. to Agri/Forest |
| Fish Processing | Fish Products |
| Chem. Fertilizer | Fertilizers |
| Fish/Poultry/Eggs | Poultry |
| Other Construction | Other Engineering Cons. |
| Auto Repair | Motor Veh. Access/Assem. |
| Livestock | Cattle & Calves |

The commodity classification schemes in the Quebec and Canadian models differed to some degree. The preceeding list outlines where some of these differences occurred and presents the Canadian commodities which were used as proxies for the Quebec commodities.

## APPENDIX E

### FINAL EXPENDITURE PRICE ELASTICITIES OF DEMAND

In Table E.1, estimates are presented of the short and long run price elasticities of numerous consumer expenditure categories. Various sources were employed in the construction of this table, each of which is enumerated in the list of sources proceeding the table. Where estimates were not available or were implausibly large, they were demarcated 'N.A.' (not available).

Tables 4.6 and 4.7 draw from data contained in Table E.1, which includes the Consumer Expenditure Categories and the corresponding estimates of the short and long run price elasticities. As in Table E.1, when estimates for the price elasticities were not available, they were marked 'N.A.'

In most cases the elasticity estimates could be transferred from Table E.1 to either of Tables 4.6 or 4.7 without any confusion. In such cases, the Input-Output Consumer Expenditure Categories corresponded directly with the Consumer Expenditure Categories employed in the study by T. Schweitzer [45]. In other cases, however, the categories did not correspond and it was found that what one study treated as a single consumer expenditure category the other would divide and treat as two separate expenditure categories.

In these particular cases, the elasticity to be chosen was dependent upon which expenditure category predominated the other in importance, i.e., which item comprised, in dollar terms, the largest portion of the consumer budget. One example is the expenditure category 'Food and Non-Alcoholic Beverages' as listed in the input-output table. The Schweitzer study further subdivided

this single category into the two categories; 'Non-Alcoholic Beverages' and 'Food Purchased at Retail'. Since the majority of the elasticity estimates were obtained from the Schweitzer study, the elasticity figures were presented for the more detailed category list.

Under these circumstances, the estimated elasticities (both short run and long run) of the 'Food Purchased at Retail' category were utilized in the compilation of Tables 4.6 and 4.7. Similar cases such as this were handled analogously. A larger portion of the consumer budget was spent on 'Footwear' and 'Precious Stones, Jewellery, Watches and Rings' than on their respective counterparts 'Shoe Repair' and 'Jewellery Repair and Engraving'. Thus, their elasticity estimates were also expected to predominate.

In some cases, there were no consumer expenditure categories listed in the Schweitzer model which corresponded with those listed in the I-O Model. In such cases, the consumer category was purposely omitted from Table E.1 but its omission, from Table E.1 did not automatically preclude it from inclusion in Tables 4.6 and 4.7. Providing elasticity estimates were available from alternative sources for these I-O consumer categories, they were included in Tables 4.6 and 4.7. These were mostly drawn from Canadian sources, but where they were not available, they were drawn from U.S. sources. As such, these latter elasticities refer to U.S. demand.

TABLE E.1

PRICE ELASTICITIES OF CONSUMER EXPENDITURES: ESTIMATES OF PRICE ELASTICITIES FOR THE FINAL DEMAND CONSUMER EXPENDITURE CATEGORIES OF THE I-O TABLE

| I-O Consumer Expenditure Categories Final Demand Commodities | Categories of Consumer Expenditure Used in [2] | Estimated Price Elasticities[g] | |
|---|---|---|---|
| | | Short Run[a] | Long Run[a] |
| Food & Non-Alcoholic Beverages | Non-Alcoholic Beverages | -0.81 | -0.93 |
| | Food Purchased at Retail | -0.48 | -0.55 |
| Alcoholic Beverages | Alcoholic Beverages | -0.14 | -0.16 |
| Tobacco | Tobacco | -0.46[d] | -1.89[d] |
| Men's & Boy's Clothing | Men's & Boy's Clothing | -1.33[e] | N.A.[c] |
| Women's & Children's Clothing | Women's & Children's Clothing | -1.33[e] | N.A. |
| Footwear & Shoe Repair | Shoe Repair | -2.46 | -1.81[d] |
| | Footwear | -0.73[d] | -1.21[d] |
| Jewellery, Watches & Repairs | Jewellery Repair & Engraving | -5.91 | |
| | Precious Stones, Other Jewellery & Watches | -1.08 | -1.02 |
| Electricity | Electricity | -0.14[h] | -1.89[d] |
| Gas | | -0.15[f] | -0.6[f] |
| Other Fuels | Gas & Other Fuels | -0.13 | -0.48 |
| Gross Imputed Rents | Gross Rents, Imputed | -0.04 | -1.30 |
| Gross Paid Rents | Gross Rents, Paid | -0.01 | N.A. |
| Furn., Carpets & Floor Covering | Carpets & Other Floor Covering | N.A. | N.A. |
| | Furniture, Upholstery & Furn. Repair | -1.01[d] | N.A. |
| Durable Household Appliances | Household Appliances | -0.63[b] | -0.35[d] |
| Semi-durable Hhld. Furn. & Suppl. | Glassware, Tableware & Hhld Utensils | -0.68 | -0.63 |
| Non-durable Hhld. Supplies | Household Operation Goods | -0.88 | -1.87 |
| Domestic Services | | | |
| Other Hhld. Services | Household Operation Services | -1.34 | -2.35 |
| Drugs & Sundries | Med. & Pharm. Products | -0.15 | -0.53 |
| New & Used Automobiles | Personal Transp. Durables | -0.21 | -0.07 |
| Gasoline, Oil & Grease | Gasoline, Oil & Grease | -0.10 | -0.18 |
| Auto Repairs & Parts | | | |
| Other Auto Related Services | Operation of Personal Trans. Equip. | -0.36[e] | N.A. |
| Purchased Transportation | Purchased Transportation | -0.23 | -0.67 |
| Communications | Communications | -0.09 | -0.36 |
| Rec., Sport & Camping Equip. | Recreational Durables | -0.88[d] | -2.39[d] |
| Books, Magazines & Stationery | Books, Newp., Mag., Stat. & Suppl. | -0.48 | N.A. |
| Recreational Services | Entertainment, Recr. & Cult. Serv. | N.A. | N.A. |
| Eduction & Cult. Services | Education | N.A. | N.A. |
| Toilet Articles, Cosmet., etc. | Cosmetics | -0.20[d] | -3.04[d] |
| Personal Care | Personal Care Services | -0.47 | -0.90 |
| Exp. in Restaur. & Hotels, etc. | Exp. in Restaur., Cafes & Hotels | -1.72 | -2.89 |
| Personal Business | Financial Services | -0.25 | -0.60 |

TABLE E.1 (Continued)

SOURCES: (I) Statistics Canada, Structural Analysis Division has provided the I-O expenditure categories.

(II) The alternative consumer expenditure categories as well as most of the price elasticity estimates were derived from Thomas T. Schweitzer [45].

(III) In addition, several price elasticity figures were not available from the Schweitzer study. In these cases, the estimatee elasticities were derived from other sources. Those price elasticity estimates which are differentiated with the superscript (b) were derived from H.S. Houthakker, Lester D. Taylor [41].

(IV) Those price elasticity estimates which are differentiated with the superscript (d) were derived from H.S. Houthakker, Lester D. Taylor [41].

(V) Price elasticity estimates which are differentiated with the superscript (e) were obtained from Sungwoo Kim [8].

(VI) Price elasticity estimates which are differentiated with the superscript (f) were obtained from E.R. Berndt, G.C. Watkins [1]. This study utilized data from the residential and commercial sectors of British Columbia and Ontario for the years 1959 to 1975.

(VII) Price elasticity estimates which are differentiated with the superscript (h) were obtained from M. Fuss, R. Hyndman, L. Wavermann [38].

NOTES: [a]'Short run' elasticity measures the reaction in the year the change occurs while 'long run' elasticity refers to the new equilibrium level to which consumption of the good or service would settle after all the dynamic reactions to the initial change have worked themselves out via the system provided everything else is held constant: Houthakker-Taylor [41].

[b]These estimates of price elasticity were derived from Houthakker-Taylor [40], first edition, 1966. They were calculated on U.S. data.

[c]When estimates of price elasticity were 'Not Available' for some consumer expenditure categories, they were denoted 'N.A.'

[d]These price elasticity figures were derived from a later edition, 1970, of the Houthakker-Taylor [41] study. They were calculated on U.S. data.

[e]These price elasticity estimates were obtained from Sungwoo Kim [8]. They refer to estimates of U.S. elasticities.

[f]This price elasticity estimate was obtained from Berndt-Watkins [1]. It refers to the residential demand for natural gas in Ontario and B.C.

[g]No price elasticities were used if they had the wrong sign or if they were implausibly large.

[h]This price elasticity estimate was derived from Fuss, Hyndman, Wavemann [38] and is a measure of the Canadian elasticity.

## APPENDIX F

### MARKET SHARES OF OUTPUT AND ENERGY BY MANUFACTURING INDUSTRIES: 1966, 1971 AND 1975

This appendix explores the relationships between an industry's share of total output and its energy intensity. The data have been drawn from census of manufacturing sources. This allows us to examine the year 1975, a year after the substantial oil price increases. Industries were grouped according to whether they were high direct users of energy, low or medium users. The range of energy intensities are given at the foot of Table F.1. Energy here is represented by the dollar value of energy and electricity per dollar of output.

The energy figures refer to direct and not total energy used in producing the industries' outputs. The dates chosen, however, namely 1966, 1971 and 1975 cover the period when most energy prices experienced large jumps.

An examination of Table F.1 shows a constancy in the shares of output going to the high energy users, while the medium energy users appeared to have gained a little in their share in 1975 at the expense of the low energy users.

There are some individual industries which, while maintaining their market share, have lower direct energy intensities. Among those in the high energy group are the paper and allied industries. Those which have higher energy intensities in 1975 than in 1971 are the non-metallic mineral producing industries, the chemical and chemical producing industries and the primary metal industries. While such individual differences exist, the evidence drawn from the broad aggregation suggests that even after the large rises in energy prices, the share of total output accounted for by each of the broad groups is stable.

TABLE F.1

SHARES OF TOTAL OUTPUT AND ENERGY CONSUMED, MANUFACTURING INDUSTRIES RANKED ACCORDING TO ENERGY INTENSITY: 1966, 1971, 1975

| Classification \ Output & Energy Shares | 1966 | | 1971 | | 1975 | |
|---|---|---|---|---|---|---|
| | % of Output[a] | % of Energy | % of Output | % of Energy | % of Output | % of Energy |
| High[b] | 25.59 | 61.18 | 24.30 | 62.22 | 24.29 | 62.44 |
| Medium[c] | 4.27 | 4.20 | 4.67 | 4.35 | 7.06 | 7.25 |
| Low[d] | 70.14 | 34.62 | 71.03 | 33.43 | 68.65 | 30.31 |

SOURCES: S.C. Catalogue 31-203P [22], Table 2, p. 284.
S.C. Catalogue 31-203 Annual [27] Table 4, p. 6
S.C. Catalogue 31-203P Preliminary Bulletin [22] Table 2, p. 4, 1975

NOTES: [a] 'Output' figures in this table were presented in the three preceding sources under the title of 'Shipments of goods or own manufacture'.
[b] 'High' in this context refers to manufacturing industries whose energy coefficients, in terms of value of fuel and electricity per dollar of output, fall between 0.0305 and 0.0685.
[c] 'Medium' refers to energy coefficients which fall between 0.0185 and 0.0305.
[d] 'Low' refers to energy coefficients which fall between 0.0025 and 0.0185.

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